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readings for the arc are read on the outer one of the three verniers, the degrees figures being just outside of the end of the ruler. The arc pertaining to the mortar battery p. f. is indicated by the lettering M. B. P. F. ARC. The middle vernier pertains to this arc when the range ruler is pivoted at its center, the degrees figures appearing in the outer of the two notches in this ruler. The inner arc has its center at the point indicating the p. f. of 10-in. battery. When the range ruler is pivoted at the center of this arc (lowest recess, fig. 1 (a), the innermost vernier becomes adjusted to such arc, and the degrees figures are read in the innermost of the two notches in the ruler.

In fig. 2 the two rulers, as already mentioned, are pivoted at the middle recess (m. b. p. f.). At the 9120 yard point of the range scale on ruler, the ruler rests on a tack (assumed as being a target pencil dot), and the middle vernier indicates the azimuth of the target from m. b. p. f. as 285° 46′.

In fig. 3 (b) the range ruler from about 8900 yards to include the tabular headings is reproduced to exact size.

The range ruler carries a range table for 12-in. mortar made up from the graphic table for mortars furnished by the ordnance department.

The column along the beveled edge shows a range scale of the usual graduations, 200 yards to the inch.

The next column shows weights of powder charges corresponding to the several zones, of which there are thirteen in all.*

In the third and seventh columns appear the elevations, to every twenty-five yards, corresponding to the several powder charges.

In the fourth, and eighth columns are indicated the times of flight, to the nearest second, for every one-hundred yards.

In the fifth, and ninth columns appear the angular drifts for every one hundred-yards.

In the sixth column are shown the number of minutes change in azimuth necessary to move the point of fall twenty-five yards laterally.

The drift ruler is a device mechanically correcting for the drift. At any point (given range) along the straight edge of this ruler, *the offset to a corresponding point in the curved edge represents the linear drift for that range to the scale of the map.* In the case of some of these offset the outer ends terminate in the outer edges of the prongs (the inner edges of prongs are not considered).

---

* Had the mortar battery been located on the ground appearing at the southern part of the chart, the direction of the channel is such that the number of zones would be but half a dozen. In the location of mortar batteries, a detail so important as this is one well worth consideration.

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NOTES:—Drills should be conducted to load the guns of the pits with dispatch. A company should be broken up in reduced detachments to serve if possible every gun, loading the trucks with projectiles and bringing up dummy cartridges. A delay will be found in this part of the service. As a part of the drill, electric primers should be used and screwed home and connections attached. Occasionally fire the electric primers to test the connections. Never fail to have the vent cleared before screwing home the primer.

Whether vessel tracking or not make a habit of laying the mortars following the course of a vessel in the channel.

MANUAL FOR THE 12-INCH BREECH LOADING MORTAR.

By Captain S. C. VESTAL, Artillery Corps.

Parts in *italics* apply only to mortars with shell hoist on carriage.

POSTS.

Gun Commander—Two yards in rear of breech, facing it.

Gunner—On left of gun commander.

Nos. 1, 2, 3, and 4—In line, immediately in rear of breech, facing it, and in the following order from left to right: Nos. 4, 2, 1, 3.

Nos. 5 and 6—At the elevating hand wheels, facing them; No. 5 on the right, No. 6 on the left.

Nos. 7 and 8—At the traversing cranks, in front of them, facing the parapet; No. 7 on the right, No. 8 on the left.

Nos. 9 and 10—Convenient to the carriage, near the entrance to the magazine.

SERVICE OF AMMUNITION.

The ammunition details for each group of mortars are under charge of a non-commissioned officer, who superintends the supply of ammunition for the group and inspects shell tongs and trolleys. He exercises immediate control over the shell room details.

The ammunition detail for each mortar consists of one ammunition corporal and five privates.

The ammunition corporal inspects cartridge room, exercises supervision over the supply of ammunition for his piece, and, assisted by one private, fuses shell.

The cartridge detail (two privates) uncases cartridges, puts empty cases to one side, and delivers cartridges to Nos. 7 and 8.

The shell room detail (two privates) operates trolley and shell tongs, and, assisted by Nos. 9 and 10, places shot in shell tray.

EQUIPMENTS AND STORES.

For each group of guns: 1 range scale, 1 difference chart, and 1 electric firing machine.

For each gun: 1 quadrant, 2 sleeves, 1 bore and chamber sponge, 1 rammer, 1 prop, 1 primer pouch, 1 primer key and wire, 1 lanyard, 1 loading tray, 1 translating roller, 2 traversing cranks, 1 funnel, 1 oil measure containing oil, and 1 wrench.

TO LOAD AND FIRE.

The Group (or Gun) Commander commands:—1. Prepare for Drill (or Action). 2. Examine Gun. 3. Load.

1. Prepare for Drill (or Action).

The senior gun commander of each group brings up range scale and difference chart and places them on shelf or table near dial telegraph.

The gunner brings up quadrant and places it convenient for the gun commander.

Nos. 1 and 2 assist each other in putting on the sleeves. No. 1 carries out lanyard and prop and places them convenient to the breech. No. 1 of the first piece of each group carries out firing machine if used. No. 2 equips himself with primer pouch, primer key, and wire; places translating roller on loading tray; carries them out; and places them on mortar platform convenient to the breech.

No. 3 carries out two water buckets containing water and hand sponge, and places them convenient to the breech.

No. 4 brings up bore and chamber sponge.

No. 5 or No. 6, as convenient, carries out rammer; and together place mortar in horizontal position.*

No. 7 carries out wrench for filling plug; also traversing crank, placing crank on traversing worm shaft on right side of piece.

No. 8 carries out funnel and oil measure containing oil; also traversing crank, placing crank on traversing worm shaft on left side of piece.

Nos, 9 and 10 bring out shot truck.

2. Examine Gun.

Nos. 1 and 2 remove breech cover, and Nos. 7 and 8 muzzle cover; fold them and place them out of the way.

No. 2 places translating roller in position; Nos. 1 and 2 open breech, No. 1 operating rotating crank handle, and No. 2, translating roller. The gunner inspects the bore, chamber, breech box, breech block, and breech mechanism. If necessary, Nos. 1, 2, and 3 clean same. Nos. 1 and 2 then close breech.

Nos. 7 and 8 remove filling plugs; if necessary, fill cylinders; and replace plugs. The gunner also inspects the traversing gear and tests the adjustment of the azimuth indicator. The gun commander tests the elevating gear, the level of the traverse circle, and the telephone and dial telegraph.

3. Load.

No. 1 disengages one of the wires from firing machine, if used, and Nos. 5 and 6 securely clamp piece in horizontal position before the breech is opened. Nos. 1 and 2 open the breech; No. 2 clears vent and removes pressure plug. When necessary to clean the bore and chamber, No. 4 brings up bore and chamber sponge, assists Nos. 1 and 2 in sponging, and replaces sponge. No. 3 washes the breech box and breech block with the hand sponge, cleaning thoroughly the gas check seat and the box, the mushroom head, gas check, and threads: wipes off the surfaces he has washed, and oils the pad, and threads of the block and box. No. 2 seats loading tray, *and at the proper time gives command to No. 4 to raise projectile. No. 4 goes to the shot hoist wheel, and, assisted by No. 5 or No. 6, raises or lowers at command of No. 2.** Nos. 9 and 10 bring up projectile, and after it is launched, *lift projectile tray from the shell hoist scoop and replace it on truck, and* remove truck.

No. 5 or No. 6, as convenient, brings up rammer.* Nos. 1, 2, 3, 4, 5, and 6 take hold of the rammer on their respective sides, Nos. 1 and 2 next the breech. At the command RAM, given by No. 2, the projectile is shoved forward into the chamber until its base is about 30 inches beyond the loading tray.

No. 2 commands: HOME, RAM. At the first command the numbers at the rammer take a firm hold; at the second, all working together, send the projectile home with all force possible. All quit the rammer, except No. 5 or No. 6, who replaces it.

Nos. 7 and 8 go for the cartridge; and returning, hand it at the proper time to Nos. 1 and 2, and immediately thereafter man the traversing crank handles.

No. 2, assisted by No. 1, inserts cartridge, pushing it forward so that its base barely clears the gas check seat. No. 2 removes loading tray. Nos. 1 and 2 close breech. No. 2 inserts primer and screws it well home; hooks lanyard in eye of primer or connects wires.

The gunner lays the mortar approximately in azimuth during the loading; when loaded, he lays it accurately. The gun commander gives the elevation.

The gunner commands: READY.

All except No. 1 quickly seek cover. No. 1 tautens the lanyard or connects wire with firing machine.

The Group (or Gun) commander commands: FIRE.

No. 1 pulls the lanyard or presses steadily down upon the handle of the firing machine until the lower end of the bar strikes.

After firing, the gun commander immediately commands LOAD. The men quickly resume their posts and duties.

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*The bore and chamber sponge and the rammer should be on the side of the piece next the parapet, to leave the way clear for the passage of shot trucks. Generally speaking, it will be found convenient for No. 5 to bring up rammer for pieces on right side of pit; No. 6 for pieces on left side of pit. ***The number not required to bring up rammer assists No. 1 at shot hoist wheel.***

Fig. 1.

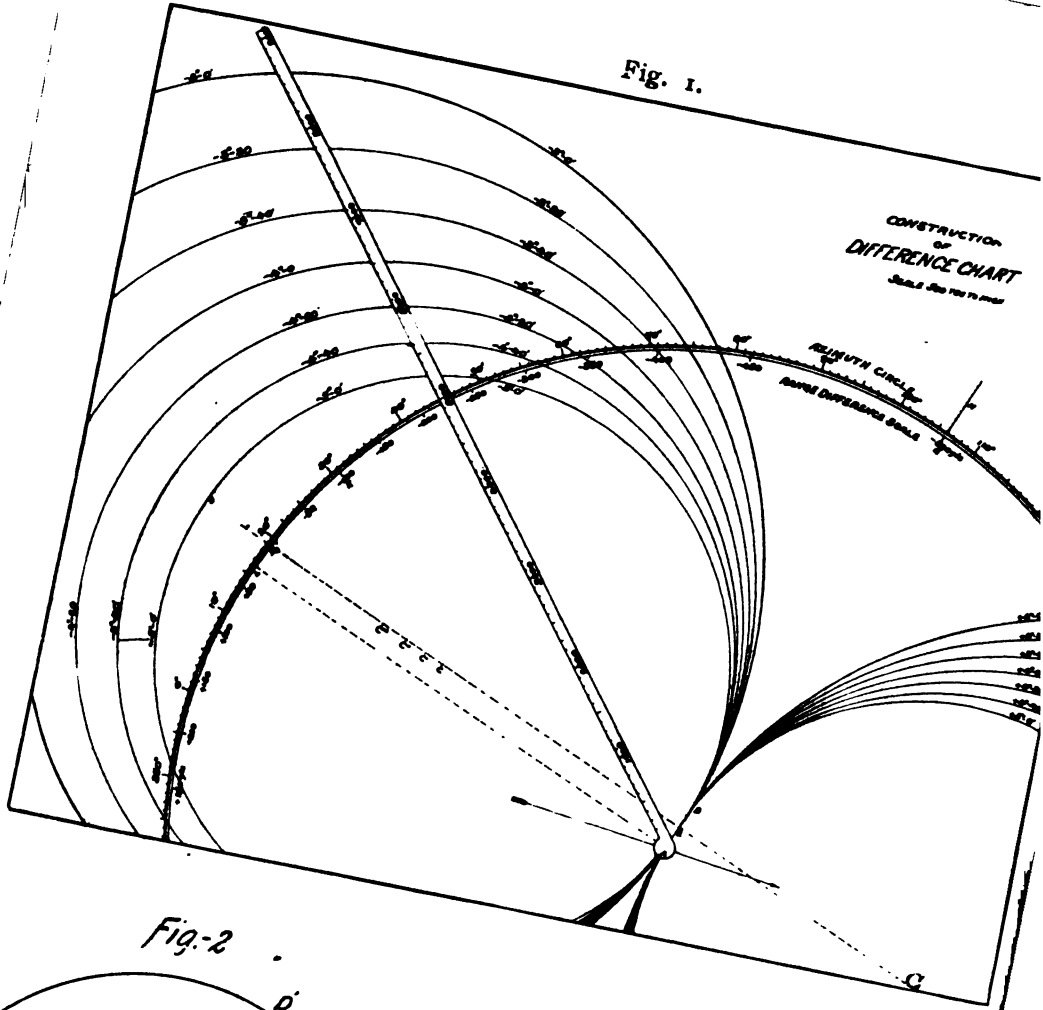


Fig.-2

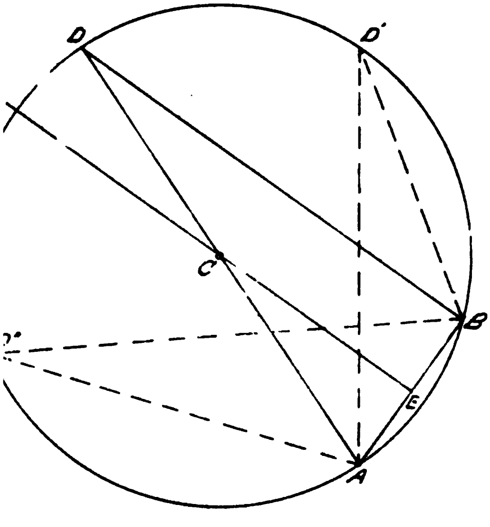
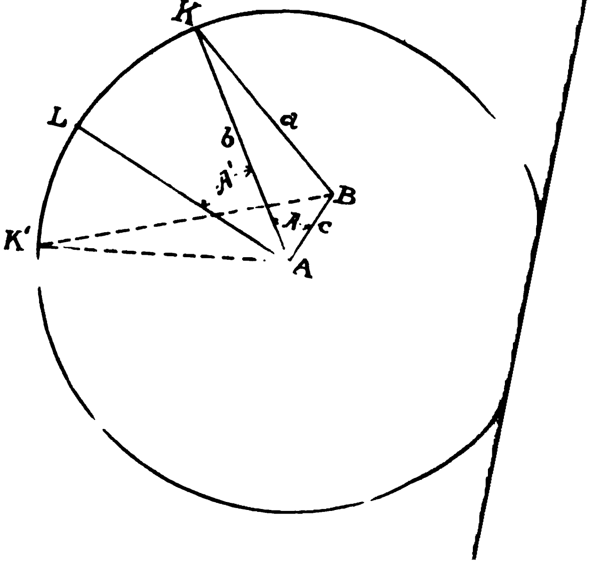


Fig 3



CONSTRUCTION OF A DIFFERENCE CHART.

By Major J. A. LUNDEEN, Artillery Corps.

A difference chart is used to obtain the azimuth and range of an object from some point, as a gun, when the azimuth and range of the same object from some other point, as a position-finder, is known.

It consists of:

Azimuth-difference circles,
A circle graduated in azimuth,
A circular range-difference scale,
And a pivoted range-scale.

Azimuth-Difference Circles.—If, in Fig. 2, A is the location of the position finder and B that of the gun for which the chart is constructed, E being the middle point of $A\,B$ and C the centre of an azimuth-difference circle passing through A and B, D, D' and D'' being points on the circumference of this circle; then the angles $A\,D\,B$, $A\,D'\,B$ and $A\,D''\,B$ are evidently equal to the differences in azimuth of the points D, D' and D'' as observed from A and from B, and as by a well known principle of geometry these angles are equal, hence all points on the circumference of this circle have the same difference of azimuth from these two points.

Since $D\,B$ is parallel to $C\,E$ by construction, the angle $A\,C\,E$ is equal to the angle $A\,D\,B$ and $E\,C = \dfrac{A\,E}{\tan.\,A\,C\,E} = \dfrac{\frac{1}{2}A\,B}{\tan.\,ADB}$.

To construct the circles, (in fig. 1) 500 yards to the inch is a convenient scale for the chart and A and B should be so located the proper distance apart and in such a position that the chart shall include all of the field of fire of the gun for which it is constructed up to the limit of its range. Then draw in pencil a straight line $E\,C$ through the middle point E of $A\,B$ and perpendicular to it and lay off on it from E (in both directions when necessary) the different values of $E\,C$ corresponding to values of the angle $A\,D\,B$ differing from each other by $2'$ or more, and from these points so found as centres, with a radius of $C\,A$, ($= C\,B$), construct the circles, marking them the proper degrees and minutes difference in azimuth and plus or minus as indicated in Fig. 1. If the position finder is in rear of the gun two sets of circles will have to be constructed, one set plus and the other minus, separated by the line $A\,B$ prolonged. If on the side of the gun but one set of circles will be needed.

Azimuth Circle.—The azimuth of *A B* being known, a circle graduated to degrees in azimuth may be constructed with a radius of about 5000 yards to the scale of the chart, centre at *A*, and marked every ten degrees as indicated in Fig. 1.

Range Difference Scale.—This circular scale is constructed with a radius a little less than that of the azimuth circle and should be drawn in red ink so as to distinguish it from this circle.

This scale will be strictly accurate only for the distance at which it is drawn but sufficiently so for practical purposes for distances greater or less than this. *F* is evidently the point at which there is no difference of distance, and *G* that at which there is the maximum difference equal to *A B*. Other points may be determined graphically with sufficient accuracy, especially if the distance between *A* and *B* is greater than 200 yards, as follows:—Continue the line *A B* beyond *G*, where it intersects the range difference circle, and from this point set off on this line equal distances each equal to the least subdivision on the scale (in the figure it is 50 yards). With *B* as a centre and a radius equal to *B H* (*A F* — 100 yards) draw the arc of a circle and where it intersects the range-difference circle at *K* will evidently be the point that is 100 yards less distance from *B* than from *A*. In the same way other points on the scale may be constructed.

A more accurate method is as follows:—

From *A* (Fig. 1 and 3) draw *A L* perpendicular to *A B* and produce it until it intersects the circle at *L*. To find the point *K* on the circle whose distance is $2d$ yards less from *B* than from *A*, we have in the oblique angled triangle (Fig. 3) the sides a, b and c given, to find the angle *A* by the formula $\sin \frac{1}{2}A =$

$$\sqrt{\frac{(s-b)(s-c)}{b\,c}}, \quad s = \tfrac{1}{2}(a+b+c).$$

A' is then evidently equal to $90^\circ - A$ or $A - 90^\circ$ and the chord *K L* can then be readily computed, being equal to $2b \sin \frac{1}{2}A'$, and laid off accurately. In the same manner other points may be found, the difference of whose distances from *A* and *B* is d, $3d$, etc.

For points on the left of *L*, $a = b + d$, $b + 2d$, etc. And on the right of *L*, $a = b - d$, $b - 2d$, etc.

In the figure d is taken as 50 yards, and should be taken a convenient distance depending somewhat upon the length of *A B*.

Range Scale:—The range scale is constructed of wood or metal, divided into 100 yard spaces and pivoted at *A*.

In order that the correct centering of this scale may be verified, two right lines should be drawn through *A* at right angles to each other, before the hole for the pivot is bored, and then on turning the scale about its pivot, its fiducial edge, should coincide with each line, if properly centered, and can readily be made so.

As it is often necessary to lay the difference chart on a small shelf when in use, or hang it on a wall, and in that case, in order to be able to swing the scale around freely, it is necessary to have the pivot of the scale away from the observer, or, when hanging up, near the top, then in order to be able to read the numbers readily the chart should be lettered so as to read right side up while in that position.

TRIANGLE FOR TELEMETRIC CALCULATIONS.

By RENZO GARRONE, Lieutenant of Artillery.

Translated from the Italian* by Captain FRANK E. HARRIS, Artillery Corps.

In that case of coast artillery firing in which the telemetric calculations are based upon the assumption that the target moves, with uniform speed over a rectilinear path during the interval elapsing from the instant the loading is completed to that in which the projectile reaches the target, the time intervening may be divided as follows:—

(a) The time to make the calculations and give the elevations to the pieces;

(b) The time to command fire, and discharge the pieces (2 seconds) and the time of flight t, corresponding to the range.

Assuming that upon the completion of the loading the target is at a point I and denoting by x the displacement of the target in the direction of fire in 10 seconds, the pieces will be ready to fire when the target is at a point F, distant $3x$ from I, in which

$$D_f = D_i \pm 3x$$

the elevations being given for the firing at a point T (distant $x/10(t + 2)$ seconds from F in which

$$D_t = D_f \pm x/10(t + 2).$$

These and the firing corrections (expressed as percentages) are the calculations which, with slight modifications, are made by the operator of the telemeter and which, notwithstanding their elementary character, are almost always entrusted to officers.

In actual warfare, as a matter of fact, the firing, the limited time interval and the din of battle generally, might very readily produce such a nervous state in the operator as would fatally react on his calculations, giving rise to inaccuracies in the operations, errors in the signs, etc.

By this system, moreover, the officer at the telemeter is deprived of his natural office of assistant to the captain in the rational employment of the fire. The materiality of the numerical operations will distract his mind from that constant supervision, that study of the vessel's path, which are so essential to the selection of the most favorable instant for firing. The firing will tend to lose its most essential characteristics by being converted into a rhythmic booming of departing salvos, at the very instant, perhaps, in which the ship begins a change of direction.

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* *Revista di Artiglieria e Genio*, September, 1901.

Under the most favorable circumstances, the salvo, all ready to fire, will be delayed by numerous calls of "time," each of which means a loss of 50 seconds of time.

This state of affairs is rather serious considering the slow rate of fire at present obtainable, and the short time during which the vessel, in the development of any tactical action as, for example, the forcing of a passage, is exposed to fire; and it tends to become still more so with the continued increase in the speed of the targets and the perfection of their evolutional qualities.

On the other hand, it is to be observed that the vessel is not at liberty to execute irregular and capricious movements; the development of the tactical action and the presence of the other members of the squadron introduce the necessity for following a definite course, the knowledge of how to profit from which epitomizes the whole art of operating a telemeter.

To attain this the officer must be free from every pre-occupation incident to computations so as to be able to concentrate all his faculties upon the target. When this obtains, if he has the good fortune to be supplied with a vertical base telemeter which is non-inverting and has a large field of vision, his post will be at the telescope.

As it is considered imprudent to entrust the calculations to enlisted men and as officers ought not be burdened with this duty, it would seem that the most obvious solution of the question would result from an instrument so simple in operation as to be absolutely trustworthy even in the hands of a soldier.

This principle led me to conceive the instrument represented in the appended drawing and designed for the long 24 cm guns. It is evident that a similar instrument may be utilized for solving the problem for mortars also.

The instrument (see plate) is made of a thin plate of platen and resembles an ordinary draughtsman's triangle from which it differs by having the more acute angle blunted and by having a raised rib along the longer side.

The instrument is graduated on its upper face, the graduations, *d*, being parallel to the raised rib above and proceeding to include the maximum range.* The zero of the scale is taken at the point of intersection of the line of graduations with the hypothenuse of the triangle.

A channel, *a*, is so cut to the left of the scale that its axis is at

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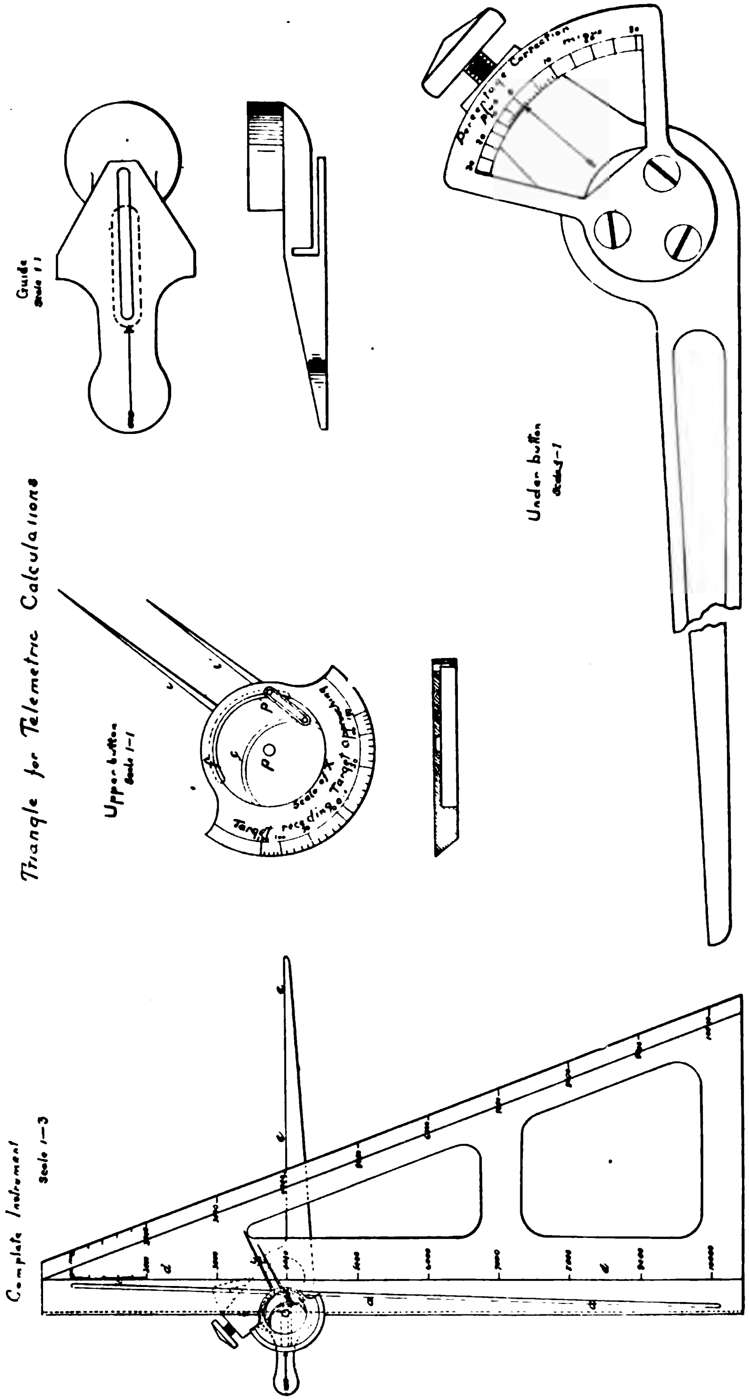
* In the drawing half a millimeter represents 10 meters and the scale is prolonged beyond the maximum range so that, whatever be the path of the target, the telemetric calculations may never limit the maximum useful range.


Triangle for Telemetric Calculations
Guide Scale 1:1
Under button Scale 1-1
Percentage Correction
Upper button Scale 1-1
Scale of X
Target receding
Target approaching
P
O
c
Complete Instrument Scale 1-3
d
e

a distance from the latter proportional to $(t + 2)$ seconds.* The graduations of the scale are projected along the hypothenuse by lines parallel to the shorter side of the triangle.

Mounted on the raised rib and sliding along it, is a sliding guide having on its under face a large pivot so constructed, that the prolongation of its axis would meet the edge of the scale in a point corresponding to the range. Upon this pivot is mounted an index arm the angular motion of which is measured by the percentage correction scale. A set screw is provided for clamping the index arm to any position of the scale.

The function of this index arm is obvious. If its fiducial edge, *e*, is parallel to the shorter side of the triangle, the range is read either upon the hypothenuse or the scale, *d*; if, however, this arm is inclined to the shorter side above, the distance read will be corrected by a certain amount Δx, which may be either plus or minus.

The index arm being firmly clamped at any inclination by the set screw, *v*, the sliding of the guide will vary the range and hence, also, the corrected Δx which varies directly with it; hence the index arm will indicate upon the hypothenuse, the range corrected by a definite percentage. The graduations for the correction scale are determined by a simple graphical construction.

On the upper face of the guide a long channel *b*, is cut, in which slides the pivot of the upper button and another pivot p', which, in addition, engages in the channel *a*.

The upper button is assembled to turn easily, is provided with a graduated lip and bears the annular slot *f*, in which engages the pivot p'.

The index *i* of the initial ranges is soldered to the button; the index i' of the ranges when the pieces are at the ready, as also the bar connecting the pivot p' with that engaging in the slot *c*, are firmly attached to the pivot p'.

By this arrangement the index i' is always constrained to move parallel to the index *i* and as the distances of the two pivots from the scale are proportional, respectively, to $(t + 2)$ seconds and $(30 + t + 2)$ seconds,† the portions of the scale included between the respective indices and the normal to the scale passing through the pivot *p* will be proportional to these quantities multiplied by the tangent of the angle through which the button was turned, and will represent, furthermore, the distances $(t + 2)x/10$ and

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* In the drawing half a millimeter represents one second of time.

† The pivot p' is at a distance of $(t + 2)$ seconds because it runs in the channel *a*, whose axis is exactly that distance from the scale: the pivot *p* being at a distance of 15mm. from the pivot p' is at a distance from the scale proportional to $(t + 32)$ seconds.

$(30 + t + 2)x/10$, respectively, provided the lip of the button has been properly graduated.

We saw above that the axis of the sliding guide prolonged meets the scale at a point which is the range, therefore the index i' will show the reading

$$D_t \mp (t + 2)x/10$$

which is the range at the instant the pieces are ready to fire, and the index i, on the other hand, will show the initial range, or the distance

$$D_1 = D_t \mp (30 + t + 2)x/10 = D_r \mp 3x.$$

The graduation of the scale of x, shown on the upper button, is also seen to be most simple.*

* * * * *

The use of the instrument is very simple.

Just before the loading is completed, the value of x, which has been previously determined, is set off on the scale of the upper button; when the loading has been completed the index i is set to read the range at the corresponding instant. The other index will then show the range at which the command fire must be given. The range to be communicated to the pieces is indicated on the scale along the hypothenuse by the lower index arm.

The correction percentages are made, when necessary, by means of the under button and as it will rarely have to be changed, the manipulation of the instrument is most simple and rapid.

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* The graduations should be extended from zero to 150 in both directions, the latter number corresponding to a velocity of about 30 knots for a vessel which is approaching or receding in the line of fire.

FRENCH FIELD ARTILLERY.

TRANSLATED FROM THE GERMAN*.

BY CHAS. A. JUNKEN.

France has kept well the secret of her model 1897 rapid fire field material. The substitution of the 75mm. (3.0-inch) rapid fire for the 90 mm. (3.6-inch) field gun is completed, and during the change, which has taken three years, slowly and by piecemeal only has she lifted the veil of secrecy attending the construction, so that even now no positive or absolutely accurate statements can be made upon essential details of the system. There was method in this secrecy; for publicity was thus not only avoided upon fundamental points of construction, important from a tactical standpoint, such as the hydro-pneumatic brake, but what is more important, yes most important, essential details and values of the entire system were withheld. What can be of greater importance to the tactician than a knowledge of the initial velocity, weight, number of balls and weight of the loaded shrapnel, and yet not a single one of these four essentials is definitely known.

Not only the weights of the limbered and unlimbered piece are frequently seen in current literature and the daily press, but also the details of the elevating device and sights are published in more daring journals. If however we wish to obtain a rigidly accurate—or perhaps we had better say a not entirely inaccurate—picture of the French field material, nothing remains but to proceed synthetically; compile the various data, combine, reconstruct the illustrations appearing in periodicals and so approach approximately correct values rather in a negative way, that is, by discarding this or that incorrect value.

Not long since the French Secretary of War promulgated and issued to the service new firing regulations, although these have not yet received the sanction of the board on military affairs. This board has only to prove that the new regulations agree with those for infantry and cavalry and that nothing therein conflicts with these two arms. In the first place the new regulations, which occupy about 400 pages, omit all paragraphs giving a description of the material, although the regulations, shortly published in *France Militaire* in a serial article, afforded an interesting insight not only into the French firing and drill methods, but also into the material itself and its organization. At the risk of repeating some known factors in what follows, the coherence and general ruling conditions concerning the material are briefly sketched.*

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* Militar Wochenblatt No. 1, Jan. 1, 1902, and No. 2, Jan. 8, 1902. 87th year. Columns 19 to 24 and 47 to 53.

The gun is of the recoil type, of **75** mm. (3.0-inch) calibre, m 32 calibers long, with a recoil on the carriage of m 1.1 m (42 inches).

This is the very system that 24 years ago was developed by the Eichweide brothers of Hannover but which in Germany found no recognition. This is not the place to discuss its advantages or disadvantages. To the trail a strong spade is attached, which in conjunction with the recoil system, and brake shoes, which when raised serve as wheel brakes, insure the steadiness of the piece when fired. Ordinarily the carriage recoils only a trifle at the first shot, until the spade is firmly fixed in the ground. This recoil as a rule, is 10 cm. (4.0 inches). The elevating device and its manipulation are ingenious, and it is remarkable that up to the present time, no description of this material gives a better insight into this detail. The essential point of this lies in the fact that the work of adjusting the angle of elevation to the range and target—by either using or not using the clinometer, that is, with or without reference to the lay of the land,—is ascertained by two persons. It must be understood that the telescopic sight is not attached to the piece but to the carriage, that is to say to the slides, and is thereby undisturbed by the recoil of the piece and can be used during the recoil. This of itself would not materially assist in the pointing; it is far more credible, and many manufacturers have also developed the idea, that the slides carry a sight made up of front sight and rear bar sight, which serve just as did the sighting arrangements formerly attached to the gun. Since however the French—and we will enlarge on this later on—lay great stress, in their rapid-fire, on making, within certain limits, frequent changes in the range and thus in the angle of elevation, it became necessary for them to devise a method for altering the angle of elevation with the least possible delay.

It is essential not to alter the sight bar to correspond with a change in elevation, whereby the line of sight for a fixed target remains constant. To this end a device is employed, the working out of which required skill, the idea (not the development) for which however depends on an original proposition, advanced by Captain Wilhelmi, the present professor of the field artillery school, in 1890, and earlier spoken of by Wille in his "Feldgeschutz der Zukunft" (field gun of the future).

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* Unless otherwise stated all data concerning weights and constant factors, of the French field gun, here cited are not claimed to be absolutely accurate, but can be considered only as close approximations. Those factors which are true for only one limit will be designated m for minimum and h for maximum. Figures, rigidly accurate, are printed in bold face type.

Whether Wilhelmi's construction has had practical demonstration or not we do not know. Just as Messrs. Eichweide came too early with their training device, so in 1890 Wilhelmi came inopportunely with his elevating device, since in both cases at each period there existed no urgent necessity to hasten the development. Though the necessity in 1890 was more keenly felt than in 1878–79, yet the Wilhelmi device was untimely, as immediately at that time the sighting bar was proposed and developed, which marked a great advance over the sighting apparatus then in use. At all events, the characteristics of the Wilhelmi sighting device and of the French so called "independent line of sight" are so devised, that one man mechanically gives the elevation and another man independently verifies it. Both constructions are subject to the disadvantage that the weight of the carriage is considerably increased thereby, and that they require two persons to point and aim, which may readily interfere with certain evolutions.

On the axle, to the right and left of the gun, are sheet steel shields, which offer protection from shrapnel fire and also from small arm fire if the range be not too short. The upper ends are 1.4 m (4.6 feet), the lower ends scarcely a centimeter, above the ground. In limbering, the portion of the shield lying below the axle is folded up so as not to interfere in travelling. The left shield is provided with quite a good sized slot in the plane of the line of fire for the aiming gunner, who whilst pointing sits upon a seat bracketted to the carriage body at a height between the level of the breech of the gun and the axle. Axle seats are omitted. The limbered piece has, for hitherto conceived ideas, the excessive weight of m 1100 kg.* (2420 lbs.) The track is 15.25 m (5.0 feet) wide. All wheels are h 1.36 m (4.46 feet) in diameter and have wooden felloes and 14 wooden spokes, attached to the metal nave by 7 bolts. The axis of the bore is h 90 cm (36 inches) and that of the telescopic sight is 1 m (39.4 inches) above the ground. The line of sight may, however, by means of a peculiar contrivance, be raised to 1.5 m (59.0 inches) and under certain conditions elevated to 1.8 m (70.85 inches) above the ground. This is a very important point, as it is then feasible to place the gun so far under cover that the gun crew are completely out of sight, though still using direct fire. Since this apparatus, which so markedly increases the height of the line of sight, cannot be loft on the gun however when fired, it precludes rapid fire. Should it become requisite to place the gun still further beneath the crest of the protecting parapet, the pointing must be done with level and sighting rod and the regulations, in this case, provide that the gunner shall stand upon an ammunition wagon, when the height of his eye will be in the neighborhood of 2.85 m (9.35 feet), and as a last extremity he can still stand on one of the buckets attached to this wagon which raises the level of his eye still further by 35 cm. (13.8 inches) that is, to a total of 3.2 m (10.5 feet).

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* See Militar Wochenblatt No. 87, 1901.

The pointing device is delicate and complicated and it is worthy of note that the rear sight includes a contrivance for laying by auxiliary sighting points like our pointing plate, or more correctly our pointing arc. Since several parts of this pointing device are loose, it has repeatedly happened that on returning from fire drill or maneuvers, some parts were missing. Moreover, the divisions on the rear sight are rather illegible. In spite of these faults, the improvement relieves the aiming gunner of a heavy task, for whilst the old regulations required 127 pages of description the new regulations reduce this to barely 15,—still another argument that a complicated apparatus, even though it be, as in our service, a gunner's quadrant with an adjustment for side slope of the carriage and a clinometer,—in its service and use may be quite simple. It cannot be too strongly accented, that it is thoroughly false, without further ado, to condemn a complicated apparatus and one difficult to make. The principal thing is that it shall be easy to use and easy to learn how to use it.

The limber has wheels like those of the carriage.

The connection between the lunette and limber hook is elastic.

The limber chest contains 24 rounds, and provides seats for three men armed with carbines and side arms. The weight of the limbered piece is m 1800 kg. (3,960 lbs.) without, and m 2040 kg. (4,488 lbs.) with men. The caisson is limbered like the gun; its rear truck contains 72 rounds. Thus the caissons contain the very considerable total of 96 rounds. In transport the cartridges are normal to the ground without any peculiar retaining device. They are contained 36 to right and left in four compartments. Half of the remaining space is filled with accessories and spare parts, whilst the remaining half contains a fuze cutting machine, wherewith two fuzes may be set simultaneously. In transport the fuzes are set for percussion. The bottom and top of the rear truck are of sheet steel. The axle is not beneath the chest, but a trifle above its lower surface. Whether the axle is bent or goes straight through the chest is not known. Probably the latter is the case. The rear truck is so arranged that it can be dropped to the rear, so as to stand nearly vertical. See figures 1 and 2, which show a side elevation and rear view of the unlimbered rear truck.

Fig. 1.

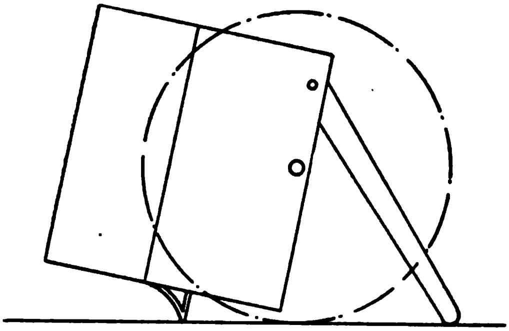
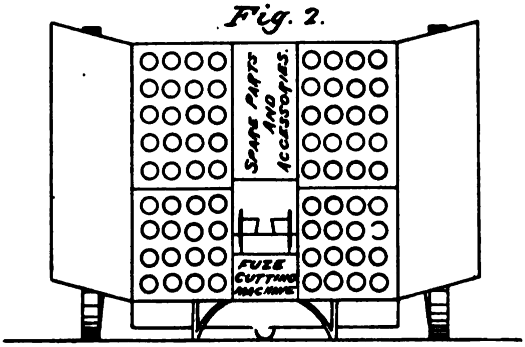


Fig. 2.



Simultaneously a litter bar drops down at the front and serves as a forward prop. For rear supports there are two small stays. The bottom of the chest is now to the front and the cover to the rear. The cover can then be readily opened to expose the bases of the 72 cartridges. To open the fuze cutting machine the cover of its compartment is folded back.

In this position the caisson serves as a shield 1.25 m (4.1 feet) high, so that kneeling men behind it are completely covered. Three men are seated on the limber of the caisson; the weight of the caisson approximates very closely the weight of the gun.

The whole equipment, including the gun, is painted grey.

The weight of the projectile is 6.5 kg. (14.3 lbs.)*; the initial velocity is h 530 m (1738 f. s.). At a range of 3,000 m (3270 yards) the terminal velocity is about 285 m (935 f. s.) The angle of fall is 8° and the co-tangent* is therefore 7.2.

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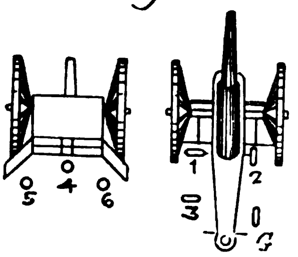
* In the first design of Model 97 a weight of 7.24 kg. (15.93 lbs.) was seriously considered.

SERVICE OF A SINGLE PIECE.

The term "single piece" is inaccurate, unless it be understood that every gun is provided with a caisson, each limbered gun with a limbered caisson, and each unlimbered gun, a rear ammunition truck.†

The gun detachment consists of a driver and six men, numbered consecutively from 1 to 6. Numbers 1 to 3 are seated on the gun limber, Nos. 4 to 6 on the caisson limber. The backward tilted rear truck of the caisson is placed close to the left of the unlimbered gun at a distance of 50 cm. (20 inches) between hubs, approximately as shown. The distribution and position of the men who serve the piece is shown in fig. 3.

Fig. 3.



Numbers 1 and 2 perform their duties seated, No. 4 kneels, and the others either kneel or stand.

Number 1, the aiming gunner, sits to the left of the trail; he handles the sighting apparatus, including its removal, gives the lateral deviation according to the range table (the sights are not arranged to correct for this) and likewise the constant lateral deviation including that of the auxiliary aiming points as we do with our directing plate and pointing scale. He further ascertains the slope of the ground, and, by means of the level, corrects for it.

Number 2, the firing gunner, sits to the right of the trail, does the elevating, handles the breech mechanism and fires; he also uses the rammer, to help unload, in case the extractor fails to work.

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* Danger space in meters for 1 m in height of target (point of burst).

† For the preparation of the limbered piece to make ready for fire, that is for bringing the gun in action, see Militar Wochenblatt No. 104 of 1901.

Number 3, the loading gunner, stands behind Number 1, shoves the cartridge in the bore, and trains the gun, particularly for the first round, by means of the trail.

Number 4, fuze cutter, sets the fuze to the proper time of burning.

Number 5, ammunition handler, takes the cartridge from the caisson and passes it to Number 4. Number 6, ammunition handler, takes the prepared cartridge from Number 4 and passes it to Number 3. He also assists number 5 in his duties. The driver and the least intelligent of the gun detachment are trained only to the duties of numbers 3, 5 and 6. Numbers 1 and 4 are as a rule first class privates. The formation by a single gun is followed by the formation in section and this by the battery.

THE BATTERY.

A battery on a war footing consists of 4 guns, 12 caissons, a baggage wagon, a field forge, a provision wagon and a fodder wagon.

For administration and service the battery is divided into the following sections:

1st Platoon, commanded by a lieutenant on the active list.

1st section	1st caisson 1st gun	120 rounds.
2nd section	2nd caisson 2nd gun	120 rounds.

2nd Platoon commanded by a lieutenant on the active list.

3rd section	3rd caisson 3rd gun	120 rounds.
4th section	4th caisson 4th gun	120 rounds.

Section III, commanded by an *adjutant.**

5th half section, 5th and 6th caissons, 192 rounds.
6th half section, 7th, 8th and 9th caissons, 298 rounds.

Section IV, commanded by a reserve lieutenant.

7th half section, 10th, 11th and 12th caissons, 288 rounds.
8th half section, baggage wagon and forge.
9th half section, provision wagon and fodder wagon.

For battle marching and for battle, the formation is altered as follows, section III being divided:

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* An adjutant corresponds in our service to a sergeant. His rank is between that of a non-commissioned and a commissioned officer, and he therefore corresponds to a deck officer in the navy.

FIGHTING BATTERY.

Firing line: (4 guns and 4 caissons).
Section I, as before.
Section II, as before.
Battery reserve: Two caissons (5th half section).
Supply train: Commanded by the reserve lieutenant since the *adjutant* is in charge of the divided section III.

Six caissons, namely three from the 6th half section of the divided section III and three from the 7th half section. Field forge and baggage wagon formerly the 8th half section.

HEAVY BAGGAGE.

Provision and fodder wagons formerly the 9th half section.

The guns and armament of the fighting battery and the supply train are provided with 6 horse teams.

Marching formation is either single or double file. In single file, guns and caissons alternate, each caisson travelling before the gun to which it belongs. In double file the gun is to the right and the caisson to the left, hub to hub, so that every caisson is directly beside its gun. The two caissons of the battery reserve follow as the 5th pair. Forming from one line of march to the other and reforming is provided for. In going into battery from double file each caisson travels either side by side or half lapping its gun till the firing line is reached; both are then halted and unlimbered; the gun limber makes a right hand and the caisson limber a left hand turn and by two circles take position behind the nearest wing of the battery. The gun is now wheeled round till it points to the enemy and the instant the rear truck of the caisson tips backward its limber pole drops down. When gun and caisson first reach the firing line it is important that the hubs of the gun carriage wheels be 50 cm. (20") in advance of those of the caisson, since we must take into account that by the dropping down of the brake shoes, which serve as travelling brakes, the gun with brakes set is dragged 40 cm. (16 inches) back, and since at the first shot it recoils 10 cm. (4 inches) to the rear. Both caissons of the battery reserve are stationed within the wings of the battery between the firing line and the harnessed limbers; they thus form a cover and observation station for the officers. The battery may also be brought into action from double file (four guns behind their caissons and on one wing the 5th and 6th caissons following, one behind the other) the caissons first halt at the firing line, the guns wait and finally fetch forward close to the right of the caissons. In limbering to the front the caisson limber is driven in front of the rear truck which in the mean time has been made ready for travelling, whilst the gun limber moves up behind its gun and is there limbered. In limbering to the rear the reverse order is maintained. Every battery is provided with a large fixed telescope. The telescope has adjustable cross-hairs and is employed for measuring elevations, such as height of burst, as well as lateral deviations. Moreover, it can be employed for ascertaining the slope of the ground and for transferring the angle between auxiliary aiming points and the target over to the position of the gun with reference to the latter. The battery telescope is thus a combination of our cross-hair telescope and directing circle.

METHODS OF FIRE.

Details of the firing regulations are not made public in just so many words in *France Militaire*, but a clear conception of the methods of fire in general can be gathered therefrom. The aforesaid rules give, so to say, a decided set-back to the views prevailing for years in France upon the sole employment of extreme rapidity of fire with modern field guns. These views, first published and advocated by Captain (now General) Langlois a decade ago, were later defended and enlarged upon in general literature by Captain Percin* and Major Roquerol†.

According to the regulations there are the four following methods of fire:

1st. Firing with both direction and elevation fixed.

2nd. Firing at fixed elevation (range) but with varying direction.

3rd. Firing with direction fixed, but with varying elevation (range).

4th. Firing with varying elevation (range) and varying direction.

1st method. This is the most simple method of fire: firing with both direction and elevation fixed is the exception and is employed principally for storming from cover with shell and percussion fuze. According to the French idea, no regular interval of fire is to be observed, but rapidity of fire, with firing pauses omitted, is called for from the commencement till the stipulated number of rounds are fired. Therefore as soon as the aiming gunner has located the target and laid the gun he calls READY and the firing cannoneer fires without a break the number of rounds ordered.

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* Repartition de feu, 1890.

† Emploi de l'artillerie de campagne a tir rapide, 1901.

(Both published by Berger and Levrault).

2nd method. Sweeping (the official term is *fauchage*, "mowing"). Here the elevation is fixed, the trajectory being merely shifted laterally, so that the dangerous zone is wide, but shallow. This method of fire is practiced with combination as well as percussion fuze. It is carried out in series of three, after each series the direction being reversed.

The amount of variation in angle for the danger space depends upon the range; it is however so calculated as to give at all ranges an interval in the bursting point of about 50 m, so that in three series a breadth of about 100 m is placed under fire, to which, with combination fuze, is to be added to either side, half the spread of the shrapnel balls. If the fire of the whole battery is concentrated and the guns laid according to their individual positions, the danger space is broadened by the three spaces between the guns, amounting at least to 15 m, that is, from 45 to 125 m, plus the total spread of the shrapnel balls. We can judge, not only from the construction of the shrapnel but from its initial velocity and the prescription that the breadth of spread in relation to the bursting point shall be about 50 m, that the angle of sheaf at the usual fighting range must be h 16° or just the same as the German field shrapnel model '96.

Applying this angle of sheaf to the ground we find that the bursting point for 50 m. spread is 170 m (185 yards) short. This broad-casting method is principally employed against long thin lines, as for instance artillery in firing position, or against a covered trench in order to take under fire the whole of its length.

3rd method. Covering depth (*tir progressif*). In this method of fire the bursting point is so arranged with reference to the range that a danger space of great depth, but of little breadth, is covered. This method of fire is only used with combination fuze. The elevation is increased by 100 meters (109) yards after two successive shots, beginning at the shortest range. After four rounds of two shots each the original (shortest) range is resumed. This method of fire is employed when it is necessary to rake a street or enfilade a line of troops, a narrow ditch or similar object of attack.

4th method. Combined ranging and sweeping (*tir progressif et fauchant*). This implies that the danger space is covered in breadth by "*fauchage*" and in depth by "*tir progressif*." It thus forms a great rectangle, which is greater in depth (range) than in breadth. This method of fire is conducted in series of three shots each,—in three series, the bursting point being separated by a breadth of 50 m (51 yards). As a rule these three times three shots are separated by 100 m (109 yards) in range, the three sweeping series then beginning. At the following 100 m (109 yards) the same program recurs, and likewise anew at each succeeding 100 m, so that the bursting point covers in groups of three shots a depth of 300 m (327 yards) and a breadth of 100 m (109 yards). In order to bring the entire rectangle under fire a single time, requires, therefore, 3 × 3 × 4 = 36 shots; or when the entire battery in one way or another executes the same sort of fire, 4 × 36 = 144 shots.

Since the bursting shrapnel covers a range 200 m (218 yards) in depth, the depth of dangerous space becomes 300 + 200 = 500 m (545 yards) and its breadth $100 + 2 (\frac{50}{2}) = 150$ m (164 yards), and the area of the space covered is therefore 500 × 150 = 75,000 sq. m. (89,380 square yards). Since every shot contains 300 balls and dangerous fragments, upon each square meter (about a square yard) of the ground covered there falls $\frac{144 \times 300}{75000} = 0.58$ balls, that is to say, the process must be repeated by the entire battery in order that a single ball shall fall within each square meter. If however, as is most likely, the fire of the battery corresponds to the space between the guns (*tir progressif, fauchant et reparti*), the area of covered ground becomes 45 m (49 yards) wider or (150 + 45) × 500 = 97,500 sq. m. (116,025 square yards) and there falls on each square meter but $\frac{144 \times 300}{97500} = 0.44$ balls. In order, then, according to the foregoing rule, that at least one ball shall fall on each square meter, this process must be repeated thrice. Combined sweeping and ranging requires therefore a supply of ammunition, which in relation to the probable execution is very high, and which even the lavish supply of ammunition of the French field artillery would not sustain for very long, although the limbers and accompanying wagons on the firing line provide 672 rounds, and the supply train 576 rounds, or a total of 1248 rounds,—312 rounds per gun. It is therefore apparent, that the latter method of fire could only be used in extraordinary cases.

The remarkably long point of burst, upon which the French seem to count, must indeed be regarded as very effective. It removes, moreover, the complaints which formerly were loud, with reference to the slight penetrative force of shrapnel balls. The range in depth of the balls, 200 m (218 yards), appears so great that we are forced to the conclusion that the two sections of the battery must fire with fuze set at 100 m (109 yards) apart. This would correspond to a "*tir progressif*" combined with a "*tir echelonné*," which latter in earlier literature was much spoken of, but which, in *France Militaire* is not mentioned.

The 4th method of fire appears to be identical with that prescribed in the firing regulations for German foot artillery, Paragraph 167, and called "Streuverfahren" (scattering method), with the difference that in the latter the training of each gun is so altered that a single laying of the whole battery suffices to cover the proposed width of the bursting-point, the elevation being increased at each laying for all guns alike. Furthermore, at any single range, that is to say at any one elevation, but one round of the entire battery is fired.

In the French method, on the contrary, it is very characteristic that for the sake of great rapidity of fire with the single guns, the training is only altered from series to series and also that the condition is required that three shots are always fired no matter how the training and elevation have been altered from the foregoing to the succeeding shots.

The French field artillery is the first to promulgate for the new armament, with rapid-fire guns, the consequent rules for the service of the piece, formation, organization, and firing regulations. All precepts contained therein are therefore worthy of earnest consideration, even if we cannot understand clearly all the conclusions and requirements contained therein. For this reason they have been granted more space than is customary.

METHOD OF LAYING HEAVY GUNS IN WHICH THE FIRE DIRECTION IS PLACED IN THE HANDS OF THE FIRE COMMANDER.

TRANSLATED FROM THE NORWEGIAN* BY MAJOR J. A. LUNDEEN, ARTILLERY CORPS.

In Russia there has been adopted a method of laying heavy guns, devised by the Russian Captain v. d. Launitz, in which the fire direction is placed in the hands of the Fire Commanders.

The method is as follows;

1. Each seacoast fortress is divided into groups of Batteries, each group consisting of a certain number of batteries which have essentially the same field of fire, and which are placed under one fire commander.

2. Each fire commander is provided with a range finder with a position finder so constructed that by laying the telescope on a moving object and by correction made in the instrument for the motion in distance and azimuth, it does not give the co-ordinates of its actual place, but automatically gives the co-ordinates of the point where the object will be after the lapse of a certain fixed time (the dead time), provided the speed and course is not changed, that is, the point where the object and projectile will eventually meet.

The rangefinder consequently gives not the co-ordinates φ and γ for the point where the object is situated when the gun is laid, but the co-ordinates $\varphi + \Delta\varphi$ and $\gamma + \Delta\gamma$ for the point where the object will be after the lapse of the dead time.

3. Each Battery is provided with a co-ordinate transformer difference chart by means of which the co-ordinates $\varphi + \Delta\varphi$ and $\gamma + \Delta\gamma$ for the range finder are transformed at the different batteries to their respective co-ordinates w and ρ, w_1 and ρ_1, w_2 and ρ_2 for the batteries B, B_1 and B_2.

4. Each battery commander corrects the given co-ordinates for atmospheric conditions and the strength of powder. It is taken for granted that the ammunition will not necessarily give the velocity given in the range tables. These corrections are made in accordance the results of practise shots at various known distances, made *during the same day that the target practise takes place.* Deflection for drift is corrected for automatically.

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* Reprinted from the *Norsk Artilleri Tidskrift.*

These co-ordinates being determined, the guns are laid by means of an azimuth circle for direction, and a quadrant for elevation.

5. They are fired by salvo for all the batteries of the group when the "dead time" has expired. The command to "fire" is given by the battery commanders, when warned "stop" by telephone from the fire commander that the proper time has arrived.

It was found by experiment that the average time that elapsed from the determination of the co-ordinates until the transformation of co-ordinates is accomplished is 49 sec., and the additional time required to lay the guns is 50 sec. more—together 99 sec. Consequently it requires about 2 minutes from the time the object is observed until the shot strikes.

If the above report is complete there seems to be several objections to this method of prediction, etc.; one is that the change in azimuth is assumed to be uniform for an object moving uniformly on an oblique line,—which is well known to be incorrect.

It also appears to be assumed that the distance from each battery to the object is the same, otherwise the time of flight would be different, and allowance should be made for that.

J. A. Lundeen,
Major, A. C.

LATE DEVELOPMENTS IN ORDNANCE AND ARMOR.*

BY J. F. MEIGS, ESQ., ENGINEER OF ORDNANCE.

Reprinted by permission from Scientific American Supplement, December 14, 1901.

In the past ten years the developments in armor plate have consisted in, first, the introduction of nickel in the armor; second, the adoption of the super-carbonizing process invented by Mr. Harvey; and, third, the perfecting of this super-carbonizing process by Krupp. Parallel with these improvements in armor plate, the tendency of which, or rather the tendency of the latter two, has been to produce armor of very hard outside face, the velocities of projectiles have advanced. From a purely rational point of view this would appear to be unreasonable, because hard armor is best attacked by heavy projectiles, which, if the size and weight of the gun remains constant, would mean a lowering of velocities. In other words, hard armor which may be cracked is best attacked by heavy projectiles, and comparatively soft armor by light, fast-flying shot.

In the ten years under review the advance in the resisting power of armor has been very material. The advance made by the introduction of nickel and by the adoption of the Harvey surface-hardening process, which was brought in at about the same time, added probably quite 25 per cent to the power of armor plate of fixed thickness to resist penetration. The adoption of the Krupp process probably added another 10 per cent to the resisting power of armor plate, and also added very materially to its power to resist cracking. It is perhaps not too much to say that the armor of to-day has 40 or 50 per cent more power to resist penetration than that of ten or twelve years ago of the same thickness. Its power to resist cracking is very difficult to measure numerically. This power, however, is very greatly increased, as much because of the better methods of melting and forging large masses of steel, as for any other reasons, It seems now almost impossible to crack well-made armor plates under conditions approaching those usual in reception tests. Their surfaces are spalled for an inch or two in depth, and the tough back of the plate is very resisting to cracking effect. In a word, when comparing the armored ship of to-day with the ship armored twelve years ago, say, with the same thickness, we find that the former has an enormous superiority.

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* Read at the ninth general meeting of the Society of Naval Architects and Marine Engineers, held in New York, November 14 and 15, 1901.

The same degree of superiority is not found in the gun itself. The guns of a fixed calibre are longer and heavier than they were, and the powder is better than it was ten years ago, but, as stated, the gun itself, though shaped differently, has not improved from improvement in quality of material so much as armor plate. Ten years ago a 6-inch gun weighed about 11,000 pounds, while now it weighs from 17,000 to 18,000. The former gun gave barely 2,000 feet with the brown powder then in use, while the later gun, with its charge of smokeless powder, will give 3,000 feet or more, and thereby its energy is more than doubled. This, however, it will be noted, is largely because the gun is heavier than the old 6-inch guns. The advantage which is most marked in the past decade in ship's guns, or, to use the more general term, in guns of position—that is, guns that are not moved from the place where they are set—is in rapidity of fire. Not many weeks since an English ship of war fired eight shots from a 6-inch gun in one minute, at a range of about 1,500 yards, at a target 15 feet high, and struck it every time. Such a feat a few years since would have been thought impossible, and, in fact many people with whom I have conversed will not believe what I have stated to be a fact, but the reports that I have read of it in the newspapers, which, of course, are available to anybody, are of such a nature that I myself believe its truth. No doubt the ammunition was close by, or it is possible that the ammunition supply arrangements may have been extremely good, and that the ammunition may have been brought from the magazine. This is unlikely, however, and in the statement that I have seen, this is not said to have been the case. The actual trial of how many complete rounds of ammunition can be delivered to each gun in a ship would appear to constitute as important a datum regarding her efficiency as her record on the measured mile. It would depend, of course, upon her structural arrangements and upon the skill of the ammunition passers.

No doubt, also, the ship's course was carefully selected in such a way as to blow the smoke away from the gun, for, although powder is now called smokeless, the heated gases coming from the gun render it impossible to aim properly until they have blown away, and, if blowing toward the firer, they would hurt his eyes so that he could not make good practice. We hear, also, of guns, whose projectiles weigh 350 pounds, being fired three or four times a minute. These things are no doubt true, in at least a limited degree, and constitute a very marked advance in gunnery, for, while it would not be possible to fire a 6-inch gun many minutes at eight rounds per minute, both because the crew would become exhausted and because the gun and other parts would heat, yet the fact that this can be done for a short time, when it becomes necessary, is a matter of great consequence. It appears that this end has been reached, principally, if not solely, by putting it into the hands of one man—namely, the firer, to do everything that is required to aim and fire the gun, without moving and without taking his eyes from the line of sight. He simply keeps the gun aimed all the time, and fires it whenever it is loaded and as quickly as it is loaded. The adoption of measures of safety whereby he, standing half way from the breech to the trunnion of the gun, and with his back to the breech block, cannot fire the gun unless the breech is properly closed and the man handling it out of the way, are details of manufacture which have been mastered.

While, of course, it is very difficult to say at what range modern ships will fight, yet it would appear that this matter must be settled before any conclusions can be reached with regard to the kind of guns to be placed in ships. For example, if the old *Pensacola*, having ten smooth-bore 9-inch guns on her broadside, can choose her range, she is more than a match for the modern *Atlanta*, of equal tonnage, carrying three 6-inch and two 8-inch breech-loading guns on her broadside. The ship that can control range can outclass the other. It is necessary to determine to what range ships will usually come before determining upon their batteries and armor.

There is much difference of opinion in regard to the range at which the modern gun is effective. Possibly this comes from a neglect to appreciate the circumstances of the use of the gun, rather than the accuracy of the gun itself. The gun is itself very accurate, but the circumstances of its use are much less so. The changes in velocity due to changes in powder, cause some variation in the range of the gun, but the greatest difficulty consists in the absence of correct knowledge of the range, and, in guns in ships, in the continual motion of the ship—both the rolling motion and the swing, when the ship is turning through an angle. My impression is that those who have witnessed a good deal of firing from guns in coast fortifications think that a ship would be in great danger from the guns of a fort in direct fire at 8,000 or 9,000 yards, and I assume that this presupposes that the range is accurately known, as it usually may be in a fort. I should think, however, that so great accuracy would be attained only when the firing is very deliberate, and when such elements as the muzzle velocity due to the powder in use are accurately known. In a ship gun, where the range is rarely accurately known, and where the ship is usually moving, accurate practice cannot be made at so great a distance as 8,000 yards. I think that most naval officers believe that with their guns, and in reasonably smooth water, they can make fair practice at 3,000 or 4,000 yards. My own belief is that this is too great an estimate. At 3,000 yards range with a target 15 feet high, when a gun is rolling at an angular rate of one degree per second, which is a fair rate only, the prolongation of the line of sight of the gun would sweep across the freeboard of a ship 15 feet high, which would include all the vulnerable part of the ship, in somewhat less than one-tenth of a second. This is a period of time too small to be appreciated by a man's nerves, and, indeed, the accuracy of operation of the firing apparatus of the gun can hardly come within this limit.

It is usual to assert that naval guns stand in greater need of high velocity than land guns in order that the trajectory may be flatter and the gunner independent of the range at great distances. At present, for practical purposes, the trajectory is a straight line—having regard to the height of the broadside of the ship—for about 1,500 yards in length. By insisting, however, upon what is now known as "power" in guns—that is, the use of elongated and fast-flying projectiles rather than those which approach a rounded form and move with lower velocity, much is necessarily lost in smashing effect. The shell charges become smaller and the mine effect of the shell becomes less, and the damage to constructions that are hit becomes less. The shot of the old-fashioned 9-inch smooth-bore guns weighed 90 pounds, while that of the modern 6-inch rifle weighs 100 pounds. For anything that it can penetrate the former constitutes a more dangerous projectile than the latter. Against the upper works of vessels the old round shot is by no means despised. This all arouses the question of what caliber of gun the designer of a warship will put in. He has a certain weight to put into battery, and the question comes to him at once: Having 100 tons to dispose in guns and gun carriages, shall it be put in so many 8-inch guns or in so many 6-inch guns? Roughly, the weights of guns vary with the cube of the calibers, and for every 8-inch gun you can have eight 4-inch. As the 4-inch gun fires a good deal faster than the 8 inch, the weight of metal and of bursting charge thrown by the battery of light guns would considerably exceed that thrown by the heavier ones. The weight of a single discharge from a battery of fixed weight, of any caliber, would remain about the same, of course. These, it seems, are the great tactical questions in regard to guns: First, having a fixed system of guns—that is, having guns of different calibers in which the dimensions are about proportional to the calibers, what size guns shall we use; and, second, there is the other question: Is the system right? That is, should 8-inch guns weigh what they do, or should they weigh more or less; or, to put it in another way, are we satisfied with present weights of guns, or do we want more velocity in a gun of fixed caliber, and are we willing to accept the increased weight that must be given to the gun to get this?

Much discussion is going on now in regard to the substitution of 7-inch and 7.5-inch guns for 6-inch guns on the broadside of battleships, and, while everybody must be desirous of increasing to the utmost the size of the guns, and, consequently, their destructive effect, it must be remembered that this inevitably makes the weight carried heavier, and in certain cases limits the speed of firing. It has been generally asserted that guns cease to be rapid-fire when increased beyond 6 inches in caliber. Even 6-inch guns must have their cartridges separate from the projectile, and, as the projectile weighs 100 pounds, it is about all that one man wants to put into a gun quickly when standing on the deck of a rolling ship.

Another matter of much interest just now, particularly in this country, is the disposition of the turrets in battleships. I had the opportunity last summer to go over the battleships *Alabama*, *Kearsarge* and *Massachusetts*, when lying in Newport harbor. It is not necessary here to describe the batteries of these three ships, as they are all known to you, but there was perhaps no sentiment aroused within me more clearly defined than that of sympathy with the various officers and boards that have been called upon from time to time to pass upon the batteries of these ships. Volumes could be written upon the subject, and no one can reach a conclusion without first forming a clear idea of what sort of combat these ships are most likely to be engaged in. As we do not know what this will be, it seems that no one can dogmatize on the subject, and that all that can be done is that the matter shall be determined according to our lights, and that thereafter we should hope for the best. In passing, however, it may be noted that American ships always, from the first, have been very heavily gunned, and that again and again this has been shown, when the time of trial arrived, to be of vital importance.

There are many minor improvements which have been introduced in the use of guns, as, for instance, the almost general adoption of telescopic sights, which give greater accuracy of fire, the use of electric firing, which fires the gun more quickly when the sights are on, the use of automatic ejectors for the primers, and improvements in fuzes. Also, high explosives have come to be used very generally in shells. These explosives are usually of the picric acid order, but have not yet attained much acceptance in this country. Many believe that they are quite as safe in shells as the old black powder, and, as they certainly break shells into a larger number of parts than the older explosives, it would appear that they are certain to be adopted in time. Also caps have been used on the point of armor-piercing projectiles, and these are becoming universal. Many theories are advanced as to why they help a shot through an armor plate, but of the fact they do so help it, there is no doubt whatever. It is said that they are least effective in oblique fire, and, while this may be so, it is yet a thing very hard to demonstrate, as the penetration of all armor-piercing projectiles falls off very quickly when the shell does not strike fairly point first. The cause of this seems to be largely that the whole back end of the projectile, upon striking a plate obliquely, is wrenched off, and the very second that a projectile, when striking an armor plate, begins to go to pieces, that second it is done for, and its chance of doing any material harm to the armor becomes nil.

In no respect, perhaps, has greater improvement in gunnery been made in the last ten years than in the practically universal adoption of smokeless powder. At present, the pure nitro-cellulose powder is generally held to be much the best. Though smokelessness is usually put forward as the great advantage of the modern powder, yet the absence of solid residue in the products of combustion would appear to be the real gain in this regard. In the old powders about 40 per cent of solid residue was projected from the gun as uselessly as though its weight was in sand, while in the modern powder all or nearly all the charge turns into gas and helps to propel the projectile. On the other hand, the gas of the modern powder, particularly where much nitro-glycerine is used in making it up, as is the case in cordite for example, is of very high temperature and scores and gutters the gun very badly. This is much less so with the nitro-cellulose variety, and with the latter, where moderate pressures are used—say, of 34,000 or 35,000 pounds—the scoring of the gun is not a very serious matter. The scoring of steel by hot powder gas is a most extraordinary phenomenon. If there is ever so little a channel through which the gas can escape, the steel is washed out and disappears in a most wonderful way. As, however, the propelling power of powder depends upon the amount of gas given off and upon the temperature to which it is heated, it is desirable, of course, to use as high a temperature as we can. In other words, if the scoring and guttering of the gas could be controlled, the hotter it is, the greater the velocity attained would be. As a matter of fact, however, when high pressures—say 40,000 or 50,000 pounds—are reached, the destructive power of the gas becomes very great. When the new powders came in first it was thought that a charge of one-fourth or one-third the weight of the projectile would be ample to give all the velocity that would be needed, but, owing to the desire to attain very high velocities (3,000 feet and upward), the weights of charges have been creeping up of late until now, in some guns, they approach one-half the weight of the projectile, which is the figure at which they stood roughly in the days of brown or cocoa powder.

It need hardly be pointed out here how important a matter this is as controlling the sizes of magazines of ships. Indeed, in some classes of artillery, as for instance in field artillery, where weight is of vital importance, there are many who believe that some form of nitro-glycerine powder may still be used, as it is with shoulder guns.

A word may now be said in regard to the improvements in the quality of steel in guns, and whatever is said about this may apply, it is obvious, to shafting. Ten or twelve years since or thereabouts, the tube of a large gun or a large piece of shafting which showed 40,000 pounds elastic strength was considered something rather out of the common; nowadays it is not all unusual to be able to secure 60,000 pounds elastic strength in the same forging. This could be attained with about 16 per cent elongation. Indeed, up to guns of about 5-inch caliber, the tube and jacket of which constitute pretty reasonably sized forgings, qualities as high as 70,000 pounds elastic strength, with 16 per cent elongation, and about 130,000 ultimate strength, have been reached at at Bethlehem. Nor is there any reason to anticipate that this material is any less safe to use than the softer material, Indeed, all the evidence goes the other way. It would not, perhaps, be desirable to reduce a gun's thickness of wall very materially in case this stronger material is used, but rather to consider the gained strength as so much surety against disastrous accident. Indeed it would be impossible to materially reduce the weights of guns without increasing that of their carriages, as with a lighter gun the recoil would become much more violent and harder to control. It would be very easy, if desired by ship constructors, to give the gun a larger base upon which to stand and to increase the length of recoil in many instances. As a striking example of this latter, it may be mentioned that modern quick-fire field artillery use a 3-inch gun 90 inches long, employing a recoil of 40 or 50 inches—that is, the gun recoils half of its own length. Of course it might be entirely undesirable to let a ship gun recoil through anything like such a distance as this, but there is nothing impossible about it if desired. Possibly one of the most striking changes made in gunnery in the last few years has been in the field of artillery. By means of the long recoil stated, and by the adoption of the so-called spade at the end of the trail, which spade enters the ground, these guns have become capable of a very rapid rate of fire and have been fired 10 and even 20 times within a minute. The men handling them sit on seats fast to the trail, and anyone who saw the field guns of a few years since, when in action, will realize what a revolution this means.

It used to be accepted as a sort of an axiom in ship design that the armor should be so distributed and the vulnerable parts of a ship so protected that no one shot could destroy her. This has led, in view of the heavy turret guns carried by ships, to the heavy side armor, and heavy armor on the turret and barbette. I think a study of naval history will bear me out in the statement that the resistance of ships has been overcome nearly always by silencing the battery and not by destroying the ship. If this is so, a ship should carry large bored guns of respectable penetrating and mine power, and their magazines and ammunition supply arrangements should be such that they could be served at maximum rate. Roughly, if the systems of the guns are the same—that is, if the guns are of the same dimensions, when stated in calibers—then for every 12-inch gun we may have twenty-seven 4-inch guns, and as the rate of fire of each 4-inch gun, owing to the size of which, the ammunition could be handled at the gun—provided it could be brought there from the magazine—is quite five times that of the 12-inch, it becomes apparent how much total metal and bursting charge is sacrificed for the heavy turret gun. Suppose a ship, instead of, say, four 12-inch guns and four 8-inch and sixteen 6-inch guns, should carry about one hundred and seventy 4-inch guns or eighty 4-inch on her broadside, or a total of fifty-six 6-inch, say. Which would be the better ship? Of course this parallel may be easily combated, but to me it means a great deal. If it be true that ships are overcome by their batteries being silenced—that is, by their men being driven from the guns—then the number of shots fired becomes a question of great importance.

At the present time it may be said that the principal guns of battleships are in turrets, usually in pairs, and are of 12-inch caliber. The thickness of the turret armor is 12 inches usually, or less. The so-called secondary batteries of battleships are composed of 6-inch guns, which are in broadside, and are often isolated by transverse armor and armor to their rear, which renders it unlikely that more than one of them could be silenced by the bursting of a single shell. These 6-inch guns are, for the most part, behind 5-inch and 6-inch armor. In other words, as the actual velocities for turret guns now afloat do not exceed an average of 2,300 feet, the turret guns of contending battleships can destroy each other only when within 600 or 700 yards range, and the guns of their secondary batteries, the ruling velocities of these being put at 2,300 or 2,400 feet, when within 1,000 yards range. More powerful guns of both classes are now being built and mounted, but a great number of 6-inch and 12-inch guns now in use would come within the approximate rule just laid down. Thus we may fix the fighting range of battleships at 1,000 yards. There appears to be no disposition to increase the caliber of 12-inch turret guns forming the main battery of battleships, though there is considerable movement looking toward making these guns longer and heavier, and, consequently, imparting to their projectiles higher velocities than those now ruling. As respects the 6-inch guns forming the secondary batteries, naval opinion is entirely at variance. In this country there are many who would substitute for the 6-inch guns 8-inch guns, and others who would substitute 7-inch guns, while in England the bulk of opinion, so far as discoverable from published accounts, is in favor of a 7.5-inch gun, whose projectile weighs 200 pounds. To this 200-pounds projectile would be imparted a velocity of 3,000 or more feet, so that the 7.5-inch gun in England is a very large and very powerful weapon. The 7-inch gun proposed in this country and developed by our Navy Department, requires a 160-pound projectile, and to the projectile is imparted a velocity of 3,000 or more feet. There is some disposition on the continent of Europe to use lighter guns in turrets than those of 12-inch caliber, which will weigh from 45 to 50 tons; but in this country and in England the 12-inch gun seems to pretty strongly held to. The secondary battery guns, however, as stated, are quite unsettled. Besides the 12-inch and 6-inch guns, protected, respectively, by 12-inch and 6-inch armor, battleships carry a large number of 3-inch 15-pounder guns, having a high velocity and having very little protection. The large armored cruisers, which, in their elements of offense and defense, now approach battleships very closely, carry somewhat smaller guns than the latter and their armor is accordingly reduced. When we come to the smaller vessels of all classes, the protection afforded the batteries is usually very little, besides the gun shields, and the side and other armor, of course, is also materially reduced.

There are many reasons why the battleship, armed with 12-inch guns in her turrets and 8-inch guns on her broadsides, which is the favorite battery with those who would push the weight of battery very far, would have great advantages over battleships carrying only 6-inch guns in their secondary batteries; but, if the muzzle velocities of the 8-inch guns be equal to those of the 6-inch guns, and the total weights of battery are about the same, the number of 8-inch guns would be one-half that of the 6-inch and the rate of fire of the 8-inch, as compared with the 6-inch, will be very materially reduced—it is, perhaps, not too much to say that it will be reduced by one-half. The 6-inch gun can be man-handled—that is to say, the shot can be handled by one man and all operations performed with ease, without the use of mechanical apparatus. There are many devices for simplifying the handling of projectiles and getting them into the gun, but it must always remain that the weight of the 8-inch shot—now 250 pounds—will remain a serious impediment in the way of handling the gun rapidly.

Very little has been said about the numerous small caliber guns, such as 6 and 3 and 1-pounders. These are now usually either fully automatic or semi-automatic in character, and occupy an important field in certain classes of naval warfare, such as the repulse of torpedo-boats, the protection of mine fields, and in landing operations. As regards a naval landing gun, it has been a rule to regard these in much the same way that the field gun on shore is regarded—that is, it is a question in which mobility is of great importance. Naval landing guns, however, must be materially lighter than the field gun of the army, which weighs, on its carriage and without any ammunition, about 2,000 pounds. This is obviously too heavy to be drawn over rough roads by men, and the naval landing gun, itself weighing some 500 or 600 pounds, usually weighs, with its carriage complete, about 1,200 or 1,500 pounds, and is of approximately 3-inch bore. The 6 and 3 and 1-pounders are usually conveniently disposed on the rail of a ship and in her tops, and are suited only to the attack of unprotected parts. The 1-pounders and 3-pounders are also sometimes used as landing guns.

To summarize results it may be said that, in the past ten years, by the use of better mixtures, by improved heat treatment, and by very marked improvement in face hardening, the power of armor of a fixed thickness to resist penetration has been increased about 40 per cent, while its power to resist cracking has been increased to even greater degree. This has been taken advantage of, in large measure, in a reduction of the thickness of armor plate on a ship's side. The total weight of armor carried is not less than formerly, and indeed it is perhaps greater than it was, but it is more spread out, and, while the protection on the vital parts is as good and perhaps better than it was, there is now some weight in armor left to cover parts that formerly were without protection.

Gun steel also—and in speaking of gun steel we may include the steel for shafting as well—has been materially improved in the period under review. The shafting steel now going into ships is very much stronger than that which was used ten years ago. It is, indeed, perhaps quite 70 or 80 per cent stronger than the former material. The advance in gun steel has not been so marked, because ten years ago the purchasers of gun steel wanted an elastic strength of about 40,000 pounds, whereas only 28,000 or 30,000 pounds was asked for in shafting. Now they both run 50,000 pounds, or even more. These very desirable and very material advances in quality have been rendered possible by the adoption of more satisfactory mixtures in the melting furnaces, and by more skillful heat treatment. They have not, however, been accomplished without much experimentation and the expenditure of a great deal of thought and money. The noted advance in the strength of gun steel has not been followed by a reduction in the thickness of gun's walls. Indeed the gun's thickness is rather greater perhaps than it was, and the increased strength serves only as an additional guarantee against disaster.

When we come to what may be called the tactical aspects of guns and armor, we find also material changes. The quality of the gun steel and of the armor, as is stated above, has advanced by perhaps 40 per cent, and full advantage has been taken of this in design. The modifications in design which have come about have been numerous. The armor is more distributed. It has come to be recognized that unprotected guns have no chance, and that 6-inch and 12-inch guns should be protected, respectively, by 6-inch and 12-inch armor. It should be noted that this means, if battleships are to penetrate each other, that ships must approach within 1,000 yards range in combat. This brings us back to the fighting range of old wooden ships, very nearly, for they had to approach within about 600 or 700 yards; and, when you consider that a battleship's 6-inch guns must have normal impact to perforate the armor protecting the 6-inch guns of their opponents at 800 or 1,000 yards, it may be said that the fighting range of ships has not so very materially altered in the past hundred years. What is here said may perhaps be combated, but, as 2,200 feet velocity in a 6-inch projectile will not, even with normal impact, carry it through 6-inch armor, nor will 2,000 feet carry a 12-inch projectile through 12-inch armor under like circumstances, it follows, when the vast preponderance of oblique impacts is considered, that ships must fight within 1,000 yards.

Finally, in closing, I want to bring forward, in order to more definitely determine the coming range of naval combat, the fact that there is one of its ruling factors which remains constant for all time. This is, the accuracy and delicacy of the firer's eyes and nerves. If a man can appreciate four intervals in a second, and if the firing apparatus put into his hands is instantaneous in action, he can hit a ship 15 feet high, at a range of about 1,000 yards, when his own gun is swinging, in rolling, at an angular rate ot one degree per second. This consideration, of course, remains fixed for all time. Another important consideration is what is usually called the "danger" space. With medium calibers, with 2,000 feet velocity, the danger space is 1,100 yards. That is to say, the gun is independent of the range, as the trajectory is so nearly flat at that distance. The new guns now coming along, having 3,000 feet velocity, have a greater danger space with existing targets, and are therefore independent of the range up to 1,300 or 1,400 yards.

Whether it is better to use a 7-inch or 7.5-inch gun of the same weight as the 50-caliber 6-inch gun—that is, about 18,000 pounds, in the secondary battery of battleships, is one of the pressing questions of the day. If the 7-inch or 7.5-inch gun has its weight increased proportionately it will, of course, be better than the 6-inch, except that its rate of fire will be less from the weight of its shot; but, if we take the larger calibered gun and accept a somewhat lower velocity, while using the heavier and larger shot and the same total weight in the gun and carriage, it may well be argued that the larger gun is the better. On the other hand, high velocity gives always an independence of the range at greater distances, and gives always greater penetration.

The designer of naval ships is therefore on the horns of a dilemma with regard to the battery of the ship, as indeed he must be with regard to pretty much all her elements, and he must be guided by judgment and by a careful balancing of conditions, so that, upon the whole, and in the circumstances most likely to occur, the ship he produces will be able to give a good account of herself.

COMMENTARIES ON CONTEMPORANEOUS ART OF DEFENSE.

By A. COLLON, Lieutenant of Artillery,
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Translated from the French* by Captain Andrew Hero, Jr., Artillery Corps.

(Concluded.)

The utility and need of absolute resistance from the points of support can no longer be contested. On the field of battle, a general rests his lines of infantry on redoubts or fortified points. As long as the latter are not carried, the position is not won by the enemy and offensive returns can produce their effects. Resistance to the uttermost degree from the supporting points is conformable to the principles of modern tactics; the necessity of supporting the guns in the intervals of an intrenched camp by permanent forts powerfully armed is none the less so. Consequently it is preferable to form the points of support of massive works capable of engaging, at first, in distant frontal and lateral action with their relatively indestructible long range artillery, and of participating, afterwards, in the defense at close quarters.

It may be added that armored forts require relatively a smaller number of troops for their defense and are better adapted to face an irregular attack.

With respect to fundamental guiding principles, the subschools present close analogies. From a technical point of view, the difference between them consists in the fact that the *school of reduced forts* always maintains the use of armor while that of the *separation of the defenses* has a tendency to do away with it and even to exclude its use altogether.

Modern requirements of the art of defense, says Lieutenant-Colonel Rocchi, do not admit of a decisive judgment being pronounced at present on the organization of the works, and in a practical science like that of fortification, no one principle ought to be applied in an absolute manner. Armor and cupolas certainly do not constitute the only and definite mode of protection for artillery; therefore it would be erroneous not to be willing to admit the safety of artillery except under cupolas, and none the less so to desire to exclude these appliances from the organization of forts. But, this Italian engineer judiciously adds, *while waiting for some new means of protection of a more ready and more eco-*

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* *Revue de l'Armée Belge.*

nomical application that may be developed to replace cupolas, it must be recognized that the latter satisfy the present requirements of the art of defense.

Projectiles too, in their turn, it must not be forgotten, have increased in cost in a still greater ratio than defensive works. The quantity of ammunition to demolish, by prolonged fire, an arch upon trial, represents a sum of much greater consideration generally, than the importance of the destructible part of the works aimed at.

It is to be noted, moreover, that a cupola offers a small target, hardly visible, and well adapted to cause ricochets of the projectiles.

All these considerations result in the fact that cupolas, which encountered from the time of their introduction such keen opposition, are to-day growing more and more in favor. The armored forts as already adopted in Belgium (on the Meuse) and in Roumania (intrenched camp of Bucharest), reduced and rendered more simple, are made use of in Denmark, at Copenhagen; in Holland, for the fortifications of Amsterdam; in Germany, at Thorn and for the works at Molsheim;[*] in Italy, and in Austro-Hungary, for certain barrier forts.

France appears to be abandoning the Mougin arrangements[†] (circular and mobile batteries) in order to enter upon the same road. She has recently transformed Fort Manonvillers, on the railroad from Metz to Nancy, into an armored work, and has just furnished the important batteries of Frouard and Pont St. Vincent with armored armaments.

Due, consequently, to the use of armor and constructions in beton, the defense has been able to regain the ground lost since the introduction of the torpedo shell. The use of smokeless powder, of high explosive projectiles, of light and mobile pieces and especially of high power long range cannon and rapid fire guns, places modern fortresses in fit condition to fight advantageously against the attack. Improvements made in artillery materiel have permitted also a reduction in the number of guns, and have resulted in the simplification of the tactics of the defense, the service of the guns, the replenishing of supplies, munitions, etc., and mobilization.

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[*] The advanced position of Molsheim is situated 20 kilometres west of Strasburg and commands the junction of the railroads towards Zabern and Strasburg on the one hand and Saales and Schelestadt on the other. It comprises two principal forts and some other works, the whole constituting a purely military position. The type of the forts is similar to that of those on the Meuse; triangular in form, a central mass or construction of beton, containing 4 cupolas for 150 mm. guns, infantry parapet re-inforced by disappearing cupolas for small caliber R.F. guns, armored observatories in the salients, scarps and counterscarps of masonry, ditches 6 meters deep, flanking defense by counterscarp galleries.

[†] Major Mougin's plans (The fort of the future--1887) possess this peculiarity: They are somewhat connected with the school of armored forts because the points of support of the girdle of forts, from 2 to 6 kilometres distant from one another, contain a certain number of guns capable of participating in the distant attack, and are susceptible, to a certain extent, of an independent defense.

The Mougin propositions bear relation to *armored fronts*, in that resistance to attacks by assault rests equally on the action of the collateral forts, and that the distant attack is met principally by mobile batteries in the intervals. The latter co-operate also, in case such occur, in repulsing sudden attacks by surprise.

As is known, the forts are, in a way, huge monoliths of beton, without ditch, the defense proper of which, beyond the co-operation of the mobile forces of the garrison, rests solely on cannon.

We may accept to-day, without reserve, General Brialmont's statement: "The advantages assured to the defender are such that we can substitute for the former axiom, *the attack is superior to the defense*, the following: *In positions constituting well organized intrenched camps, the defense is superior to the attack, and this superiority will become greater with the increase in power of the means of destruction*".

In the first place, the systematic destruction of various constructions, bridges, culverts, etc., existing in the neighborhood of the place, will oblige the assailant to undertake long preparatory measures which will give some indications of his intentions and furnish the means of directing against him the fire of the long range pieces of the defense.

Secondly, when the artillery of the attack and that of the defense get within view of each other, the defense will not have to await any favorable moment for commencing action, since the attack will be obliged to advance under fire.

The defender will also be able to oppose the occupation of positions from which the attacker might act decisively against the place, and in every case render such positions difficult of access.

Superiority in the artillery duel will finally belong generally to the besieged, as they are not impeded by any considerations of time nor by any of the difficulties of transport. Beton and steel, of which he alone will be able to make an extended use, will offer a sufficiently prolonged resistance to torpedo shells, for the object of the fortification to be attained.

Admitting, even, that the *combating artillery* of the defense be reduced to silence, the assailants would yet have to overcome the resistance offered by the armored works for the near defense. This resistance will be surmounted with difficulty if the defense has been able to preserve a part of its artillery in condition to act at the decisive period.

The internal action of the works will be completed by the fire of the modern small arm, which, brought to bear at the opportune moment, is sure to produce a result many a time of predominating effect in the defense at close quarters.

When, finally, the attacking forces will have succeeded in obtaining possession of the principal line of resistance, it will remain for them to overcome the second line of defense that many modern fortified positions possess, or to counter-batter the batteries erected at 1500 to 2000 metres behind the first line.

Furthermore, it can be admitted, we believe, with General Brialmont, that the art of fortification has reached at the present time a point where it will without doubt rest for a long time, for guns, powder and projectiles have acquired a power of destruction that it will be difficult, if not impossible, to increase to any notable extent.

There are more powerful explosives than those which have been used up to the present time in firing experiments with torpedo shells, but their use with modern artillery presents dangers that prevent their adoption. If there is found an explosive of the same power as these, or of a greater power, which does not decompose at all, and will resist the shock of firing, there will be even then no cause for losing faith in permanent fortifications; for, in virtue of the principle that to every force there may be opposed a resistance which will destroy its effects, it will suffice to reinforce masonry and armor. Such procedure would entail no modification in trace, interior organization and armament of the forts.

In the construction of fortified positions, there should be taken into consideration only the existing means of attack, as no one can say what the future may produce. If the building of fortresses were given up simply because new means of attack might arise, it would also be just as well to stop issuing cannon and weapons to armies, because some day arts and manufactures will produce more powerful ones. That would be all the more logical in fact, as a defective armament has to be completely renewed, while fortresses lacking the necessary strength can be maintained in fit condition by adaptive measures.

These modifications are being made at the present time in several countries, and will again be made in the future, each time new improvements and progress in armament will have caused masonry work and armor to lose their momentary superiority.

Progress in artillery should end, accordingly, not in the suppression of permanent fortifications, but in their transformation by the reinforcement of arches, the substitution of cement beton for brick or stone masonry and the installation of the artillery in cupolas.

In the present state of the struggle between the means of attack and defense, the following conclusions may be drawn :

1st. Armored forts of beton masonry will offer a longer resistance to rifled guns throwing torpedo shells than the old forts, with their artillery without cover, did to smooth bore guns and mortars using solid shot and spherical projectiles.

2d. The attack of these forts will necessitate the use of mines. This will considerably increase the duration of the siege.

Upon the whole, the means of action and of execution have alone changed. To-day, as in the time when there were neither rifled weapons nor torpedo shells, neither smokeless powders nor rapid fire guns, the fundamental principles of the art of fortification and of the defense of fortified places have maintained the same stability as those of strategy and grand tactics*; but the organization of the fortresses, outside of general elements or considerations which depend on political factors, ballistics, economics, the end to be attained, and circumstances varying with the times, can not exact invariable rules or formulæ.

The principles formulated by the Belgian Engineer will constitute for a long time yet, if not always, those of the art of defense, but their application will vary. Those who wish to find the panacea that will enable States to dispense with absorbing in the construction of fortresses an important part of their budgets, should understand that no barrier can resist the march of progress, and that decline sets in when no longer advance is made. It is most important, then, that fortifications keep abreast of the requirements of their epoch; *at that price alone*, can they fulfill the purpose for which they are created, namely :

1st. To assist the operations of armies, and impede those of the enemy.

2d. To detain around fortified positions forces very much greater in number than those necessary to defend them.

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There remain to be set forth the principal conditions to be fulfilled by intrenched camps at the present time and by the forts of these camps.

Every permanent intrenched camp should be composed of :

1st. A line of fortified posts serving to delay the investment, and the construction of the first batteries of the attack. This is the *advanced position*.

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* Or strategy of the battle field.

The occupation of *advanced posts* is prescribed by the Belgian, French and Italian Regulations. In Germany and Austria, it seems that, as a rule, they are not admitted. The question is very much discussed, but an examination of historical examples proves that the resistance of advanced posts, judiciously chosen and established, is an element of success in siege warfare as in war in the open field, notwithstanding the inevitable abandonment of these positions at a prescribed moment.

2d. A girdle of forts spaced about 3,500 metres apart, on which is expended the main effort of the defense. This is the *combat position.*

In the organization of fortresses composed of forts of independent defense, it is necessary to avoid too great intervals. It is the fear of having a daring adversary profit by the latter and penetrate between two points of support in order to try to take possession of the fortress by a bold stroke, that has led the partisans of *armored fronts* to organize this principal line of resistance with over-scrupulous care in order to give it a kind of continuity.

It does not suffice, either, for the forts to protect simply the intervals: the ground in front of the collateral forts, especially in the sectors of probable attack, must also be covered. This will obtain, as a rule, by constructing redoubts or intermediate batteries in the intervals between the principal supporting points when the latter are more than 3,500 metres, (the efficient limit of shrapnel fire), distant from each other.

3d. A second line or *supporting position* which ought to render untenable the parts of the first line that may have fallen into the hands of the enemy, cover the retreat of the artillery from this line, and assist in offensive returns by the general reserve.

The creation of a second line of defense is also strongly controverted, to a less extent, however, than that of advanced posts.

Certainly this new position will be less strong than the main line of resistance and will end almost always by falling into the hands of the assailant, but by how much will the bombardment of the nucleus and the capture of the enciente be retarded? This will depend on the good organization of this protecting position and on the behavior of the mobile forces.

4th. *A line of security* or *the enciente*, the principal object of which is to make the city secure from an attack attempted after a defeat in the open at the beginning of the investment or after the capture of a fort, with the object of burning or destroying stores and supplies, casting dismay amongst the inhabitants and obtaining a premature capitulation.

The enciente should be impregnable to attack by assault even after a bombardment by field artillery. The object of fortifications would be entirely misunderstood if, for want of a sufficient enciente, places were liable to fall by surprise or sudden attack.

In order that the enciente may be sufficient and answer its purpose, it must be constructed in time of peace; the mobilization and preparation for defense of a fortress of great development already necessitates so much work, that it will be but rarely possible to erect at the time even a rudimentary enciente. Always the most simple trace will be made use of in the permanent enciente: points of support spaced about a thousand metres, armed with rapid-fire guns, extended polygonal fronts,* profile secure from escalade, indestructible flanking defense,† accessory defenses established on the glacis and made up of thorny shrubbery; bomb-proofs for the whole or a part of the garrison.

The advanced line should be placed from 2,000 to 3,000 metres from the line of forts, that is to say, at good range for time-fuze fire, so as not to lose the support of the fortress artillery.

As efficacious bombarding range by means of long and short siege guns does not exceed 7,500 metres, and as the bombarding batteries can not be established at less than 2,000 metres from the girdle of forts, this main line should be placed at a distance not less than 6,000 metres from the enciente.

As to the second line, the general rule is to construct it at about 2,000 metres from the first line, and to rest its extremities on the two forts next to those of which the enemy may possibly take possession.

In intrenched camps which do not have a girdle of old forts serving as a second line, this line will be constructed during the siege of the forts of the first line and will be composed of redoubts, temporary batteries and shelter-trenches.

In his studies on the art of permanent fortifications, Major Deguise demonstrates at full length, quite in the same way as General Brialmont, the necessity for an enciente for intrenched camps. With respect to the other conditions that should be satisfied by fortresses of great development, Major Deguise completely agrees to the principles as expressed above, since he assigns the following rôle to the mobile reserve of the defender:—

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* 800 meters on a dry site, more extended still on a wet site if the terrain permits.

† On a wet site the adoption of the triangular profile allow the besieged to sweep the ditch with direct fire from small arms and rapid-fire guns under cupolas.

I. To occupy the terrain up to a distance that may be as much as 15 kilometres, by means of advanced posts or covering points.

II. To oppose the capture of the sectors of investment and retard the change from the preliminary investment to the final or complete investment.

III. To harass the operations of the attack foot by foot, by disputing with the besieger the ground necessary for the establishment of his batteries and his works of approach.

IV. To defend with the greatest energy the girdle of forts along the extent of the front attacked.*

V. To defend the interior line in rear of the front attacked. (Tactics of siege warfare, 1898.)

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A *fort of an intrenched camp* should satisfy the following conditions; it should:—

A. Occupy a point from which the surrounding terrain and the approaches to the position may be efficaciously covered.

B. Be impregnable to assault, even after a long bombardment.

C. Have a strong armament under ordinary cupolas, for firing against distant positions and batteries of the attack (*armement de combat*); have, in addition, an armament comprising rapid-fire guns in disappearing cupolas, to cover the terrain at near distances, and guns for the flanking defense in counterscarp galleries or caponniers. (*Armement de sûreté*).

The cupolas will be arranged as far as possible in such a manner as not to have several in the same line of fire.†

Only a part of the artillery for the distant attack will be mounted in the central mound of beton, in order not to deprive it entirely of direct fire which is most efficacious against moving targets.

D. Have a single crest and a minimum command.‡

E. Have the ramparts arranged in part for use by infantry, whose co-operation is necessary in repulsing storming attacks and assaults.

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* In order to achieve this result Major Deguise has the organization of the main line rest on points of support, about 2,500 metres distant from one another, formed by strong works capable of an active defense by small arms, energetically conducted. There must be in addition, he says, a mutual defense and a strong organization of the intervals between the points of support. (Attack and defense of fortresses.)

† According to Major Deguise, the best distribution consists in placing the armored mountings, every time it may be possible, on a normal to the capital of the fort. This leads to the adoption of works of slight depth. It must be absolutely avoided that any two cupolas, containing pieces intended for the distant attack, should be situated in the same plane of fire.

‡ The minimum command for forts with wet ditches is 8 metres.

F. Be capable of being defended foot by foot and of being retaken by offensive returns.

The existence of a keep will increase the value of a supporting point, if it is constructed so as to preserve the fort's defensive power after the enemy may have penetrated in the fort.

G. Have bomb-proof quarters, store-rooms and magazines for protecting the garrison, stores and provisions, and ammunition.

H. Have a sufficient number of wells to furnish water necessary for the garrison of the defense.

I. Be provided with an armored light-house and with one or two movable projectors for exploring the terrain.

J. Possess one or several armored observatories, depending on the situation.[*]

K. Have the premises of the gorge front protected against direct fire with full charges from the enemy's field artillery that may have succeeded in getting within the intrenched camp.

L. Have constructed on the ramparts bombproof traverses of beton in order to store under their cover rapid-fire guns on wheeled carriages.

M. On an elevated site, be provided with a system of countermines, and entrances or mining galleries and branch galleries.

The following remarks also apply to these forts:--

N. The main guaranty against attack by open assault consists of the flanking defense.

O. After the flanking defense, the best security against such an attack lies in the obstacle presented by the ditch preceded by a glacis planted with thorny shrubbery.

This advantage is very often given up through economy. The scarp revetment is in that case replaced by an iron grating or a detached wall, indeed, even by a palisade, a double hedge of barbed iron wire (forming artificial thorns), or an abatis interwoven with iron wire, lying at the foot of the slope of the scarp.

P. A great many engineers[†] are of the opinion that every fort and every fortin of the intrenched camp should have "traditor" batteries to defend the intervals and cover the ground in front of the neighboring forts.[‡] General Brialmont and Lieutenant

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[*] In the forts on the Meuse, the man-holes of the cupolas for the 120 mm. and 150 mm. guns, and the loopholes in the armored electric light house take the place of observatories.

[†] Colonels Voorduin, Crainiciano, Welitschko and Leithner; Major Lo Forte and Captain Deguise.

[‡] According to Major Deguise, these permanent and indestructible works form an integral part of the forts and are established either in a salient on the gorge front, or towards the extremities of this front, or, again, in the capital of the fort, sometimes, however, the "traditor" batteries will be placed outside of the points of support. In vol. II.—1900 of the "Collection of technical works, etc.", already cited, the author reverts again to the reasons which have caused him to prefer "traditor" batteries. As a new argument, he lays stress

Colonel Leithner consider that cupolas can supply the place of these batteries. The former of these engineers prefers, indeed, cupolas because their guns can take part in the artillery combat and fire against the works of approach, while those of the "traditor" batteries can come into action only during the contingent attack on the intervals; in case of the direct siege of the fort, it may happen, then, that they may not have an opportunity to fire a single shot.

Q. The fort's resistance will be increased by the judicious use of accessory defenses and trees, shrubs, etc., as screens, but there should be avoided the exaggerated use of them indulged in by the engineers who make them the principal, if not the only guaranty against the attacks by assault.

On the threshold of the XXth century, the colossal work of General Brialmont triumphs over almost all the controversies which it has given rise to during these last forty years. It has moulded the durable bases of the art of contemporaneous defense.

After having been the innovator of the most daring transformations in the defensive art, the continuator of Vauban and Montalembert, has the rare good fortune of seeing his ideas definitely admitted and accepted by the majority of military men.

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on the fact that the assailant will be obliged to erect and arm "counter-traditor" batteries at some hundreds of meters only from the principal line of the fortress, in order to sustain and support his *march of approach* and to annul the flank action of the "traditor" batteries.

According to Colonel Voorduin's plans the "traditor" batteries are masked casemate batteries in the gorge. They are entirely masked by the fort itself from the view of the enemy in the angle of front fire.

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PROFESSIONAL NOTES.

ARTILLERY MATERIAL.

Some Interesting Features of the Krupp Works at Essen.

By HENRY L. GEISSEL.

One of the most attractive features at the Columbian Exposition in Chicago was that of the great Krupp works. Since that time this firm has made no similar exhibition, but it is just announced that a display, which will cost over a million dollars, is being arranged for the industrial exposition to be held in Düsseldorf. There is no industrial plant in the world the story of which is more interesting.

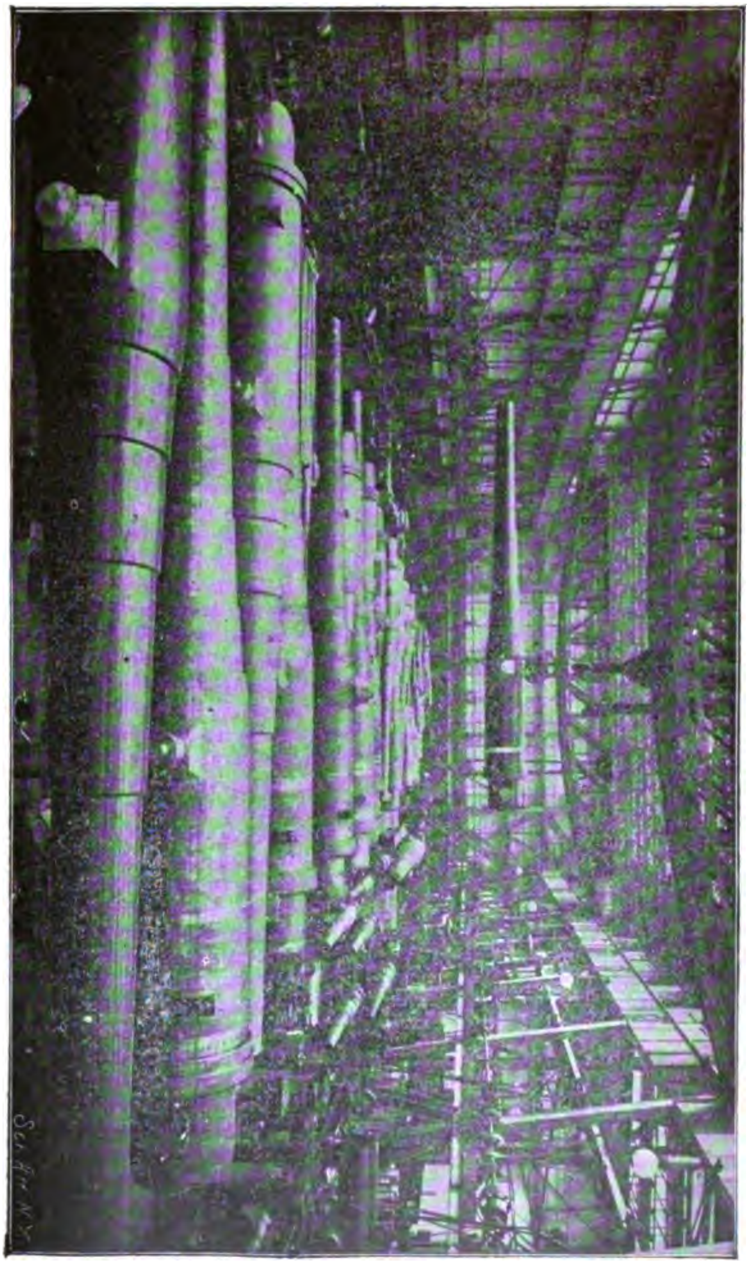
Within a few German miles of the Rhine, north of the Ruhr, in fertile, undulating, yet not attractive country, surrounded by the most important coal mines in Germany, lies the town of Essen. With the exception of a time-honored cathedral, Essen, despite its age, can boast of no historical relic of ancient days. The square before the town hall is embellished by a bronze monument from the master hand of the sculptor Schaper, representing not a king or hero, but a man clad in a simple citizen's coat, whose right hand rests on an anvil, and whose penetrating eyes are overhung by a thinker's brow. The granite pedestal bears in golden letters the words: "Alfred Krupp."

The town of Essen has erected this life-like statue in grateful commemoration for generations now and to come of her most distinguished son. For this man, sprung from an old and honorable family in Essen, within the time of half a generation, raised the small unknown country town to its present importance and celebrity. He did not sit in the Council of Aldermen, but in the small steel foundry, inherited from his father, which employed hardly a dozen workmen. This steel foundry, however, rose to world-wide fame, and grew beyond all limits. At the time of Alfred Krupp's death, in 1887, the number of employes and workmen of his works was 25,000.

On April 1, 1901, the number of hands employed in all the Krupp works, including 3,823 engineers and office men, amounted to 46,077. A few figures, for which the writer is indebted to the courtesy of the administration of the Krupp works (who also, by the way, supplied the photographs reproduced with this article), show the immense extent of Krupp's establishments.

During the year 1900 the works at Essen consumed 937,172 tons of coal, or an average of 3,123 ton per day, representing four railroad trains of 40 cars, each of a capacity of 20 tons. The other Krupp works consumed 655,125 tons, making a total of 1,592,296 tons, or 5,307 tons per day. The consumption of water at the Essen works, during the same year, amounted to 560,000,000 cubic feet, or equaled the annual water consumption of the city of Amsterdam. The gas consumption at the Essen works in 1900 was 665,000,000 cubic feet, as compared with 660,000,000 cubic feet consumed in 1900 by the city of Breslau. The number of gaslights outside of the workshops was 2,658, and that within the shops 43,012. The gas works of the Krupp works are the sixth largest in the German Empire.

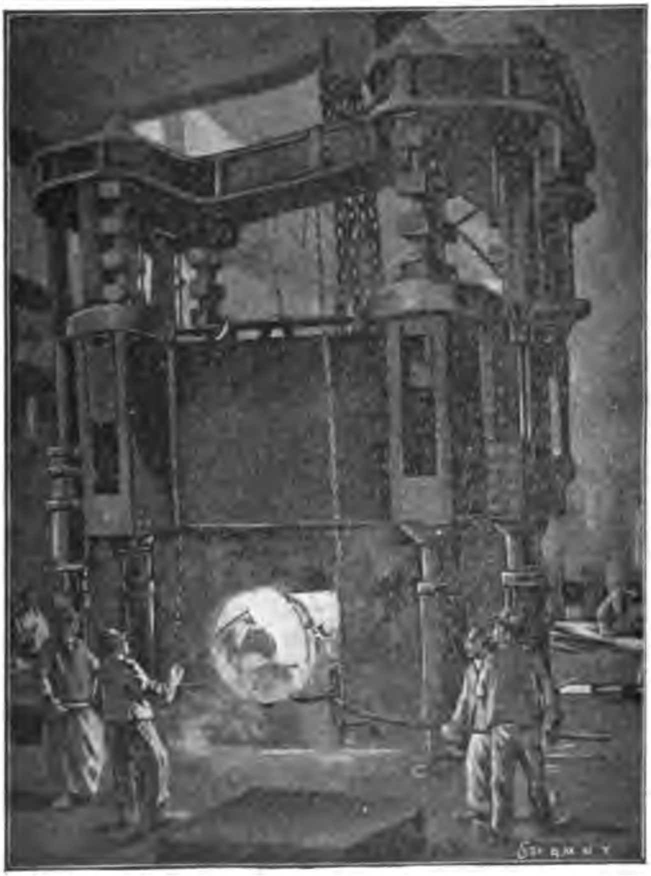
The electric plant of the steel works includes seven distributing stations, 128 miles of cable, 1,062 arc lights, 9,097 incandescent lights, and 304 motors. The railroad system of the Essen works has a combined length of 68 miles,



In the Gun Shops at Essen.

and the rolling stock includes 44 locomotives and 1,920 cars, while the telegraph system has a length of 52 miles and 37 stations, equipped with 58 Morse apparatus, the length of the wire lines being 278 miles. The average daily calls during 1900 were 1,100.

Krupp's fire brigade consists of 110 men, 85 electric signal stations, and 492 fire hydrants.



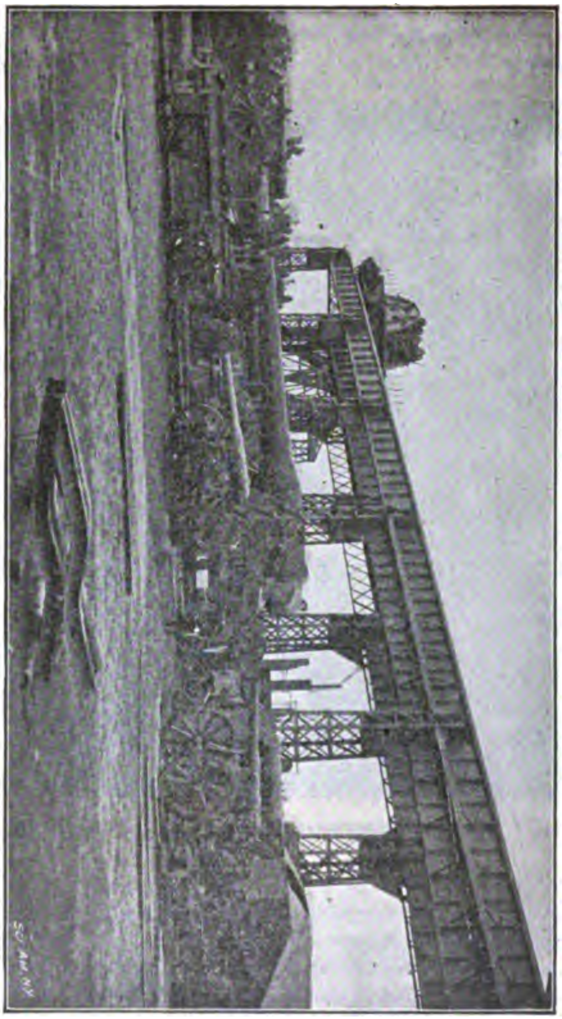
5000 TON HYDRAULIC PRESS.

There were in operation at the Essen works during the year 1900: 1,600 various ovens and fires, 4,555 machines and machine tools, 132 steam hammers, 30 hydraulic presses, 316 stationary steam boilers, 497 steam engines, 558 cranes. In addition to the Essen works, the firm of Friedr. Krupp owns and operates the Annen Steel Works, formerly Asthöwer & Co., which Krupp acquired in 1866, and whose proprietor he made a member of his directorate. These works supply chiefly gun barrels, ship and railway materials, rudder frames, locomotive and car wheels, etc. About 1,000 hands find employment at Annen.

During the year 1893, the Gruson works of Buckau-Magdeburg became

Krupp's property. These works make a specialty of the manufacture of iron-clad turrets, mining machinery, etc. Last year some 4,000 men were employed at the Buckau works.

The Germania Shipbuilding Yards, at Kiel, were added to the Krupp properties in 1896. The yards have turned out many battleships, cruisers, torpedo-boats, etc., and built also the Imperial yacht "Hohenzollern."



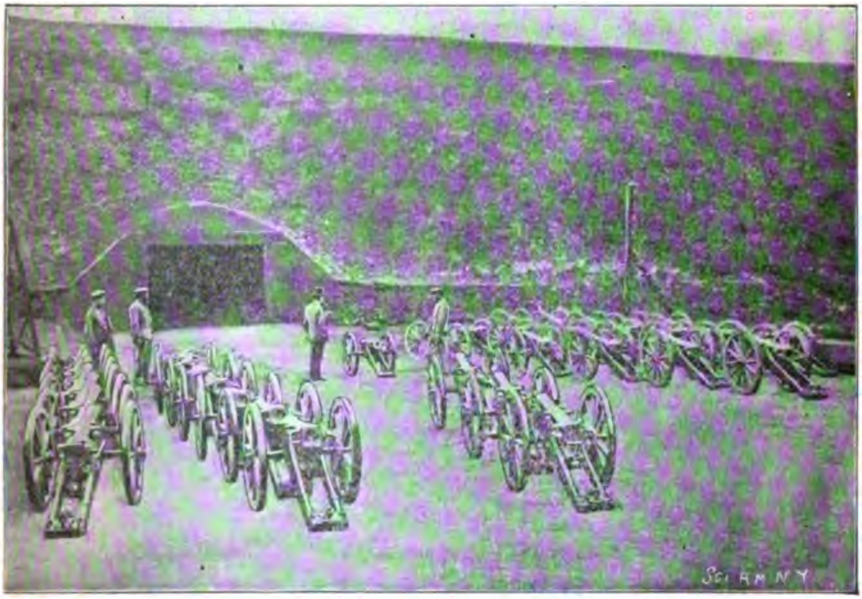
Proving Grounds at Meppen, Showing the Traveling Crane for Shifting Heavy Guns.

The firm furthermore owns and operates four metallurgical works with large blast furnaces at Duisburg, Neuwied, Engers, and Rheinhausen; steel works at Sayn, four coal mines, 500 iron ore mines in Germany, several mines in Spain, a proving ground at Meppen, three sea-going steamers, several clay, brick and stone yards, sawmills, etc.

One of the most interesting features is the Meppen proving ground, where heavy guns are tested. The middle yoke of the great traveling cranes for handling heavy guns is calculated to carry 200 tons, and the cranes, by their combined capacity, lift a 120-ton 17-inch gun from its 16-axle transportation car and place it on the carriage. The big gun and its four brothers are the largest in the world. Their armor-piercing projectile weighs 2,000 pounds; it is the height of a tall man, and when propelled by a charge of 904 pounds of brown prismatic powder, it has an initial velocity of 1,980 foot seconds, and an initial energy of 60,000 foot tons. The proving ground is also equipped with a complete meteorological observatory, in order to determine the resistance of the air, the velocity and force of the wind, the density of the air temperature and barometric variations, etc. Some years ago, in the presence of the German Emperor and Herr Krupp, a 9.45-inch coast-defense gun, of 40 calibers, with a charge of 93 pounds of smokeless powder, fired a 174-pound shell a distance of 22,120 yards, or 12.6 miles. The curve of the trajectory would have passed over the Alps near Mont Blanc and its summit, which reaches an altitude of 21,594 feet, and would have risen above the top of Mont Blanc. Although this is the longest range ever reached in an experiment, it is by no means the limit which to-day can be obtained.

One of the Krupp Steam Hammers, Showing the Crane for Handling Material on the Anvil.

One of the cuts shows a view of the Essen shooting range. This place is situated right in the works. Properly speaking, it is not a shooting range, but rather a very extensive and costly testing place for the gun shops. Here, by a number of rounds, the resistance and working of the mechanisms of the completed guns and carriages are tested. This ground also serves for ascertaining whether the ballastic capacities of the guns are satisfactory. Another illustration shows one of the 5,000-ton hydraulic forging presses. Four cylindrical columns support a solid transom, from the lower side of which protrudes an iron cylinder 3.4 feet in diameter, which carries the hammer. A crane brings from one of the open-hearth furnaces the mass of hot steel, which is put on the anvil, and the ram descends slowly and noiselessly upon the ingot, flattening it like a piece of butter. The hydraulic pressure used is 8,509 pounds per square inch, yielding a total pressure of 5,000,000 kilogrammes, or 5,000 tons. When this press makes only twelve strokes a minute, and by each of them compresses the ingot two inches, this would correspond to the work of 666 horses.



A GROUP OF FIELD GUNS AT THE PROVING GROUNDS, MEPPEN.

The Krupp works, however, are not only engaged in the manufacture of deadly weapon and war material, but many other articles are made. Steel rails, wire, iron and steel in bars and rods, structural iron, steel and iron wheels, armor-plates, sheet iron, steel forgings, steel castings, anchors, rudders, stems for vessels, steel shafts and cranks, springs, and many other things are turned out in immense quantities.

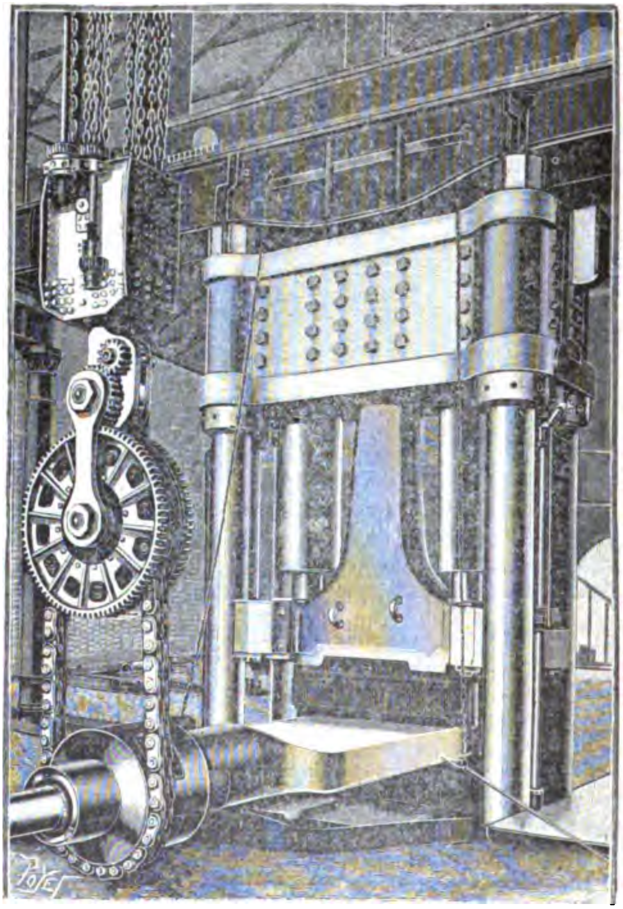
The present owner of the firm of Friedrich Krupp is Herr Friedrich Alfred Krupp, son of Alfred Krupp, and grandson of Friedrich Krupp. Last year the German Emperor, while visiting the Krupp family at their palatial country residence at Hügel, near Essen, bestowed upon Mr. Krupp, who is a close friend of His Majesty, the rank of an "Actual Privy Councilor of Commerce," which position in Prussia, carries with it the title of "Excellency." At various times the Krupps have been offered a baronetcy, but they always politely declined, urging that they would rather rank among the "first citizens" than among the "last noblemen" of the empire.

Though Mr. Krupp dictates the policy of his immense enterprise—of which he is sole owner—in person, yet the general administration rests with a Directorium," composed of twelve members. The directorium is composed of financiers, engineers, military, naval, commercial and technical experts of highest standing. It is a kind of cabinet, over which the gun-king presides.

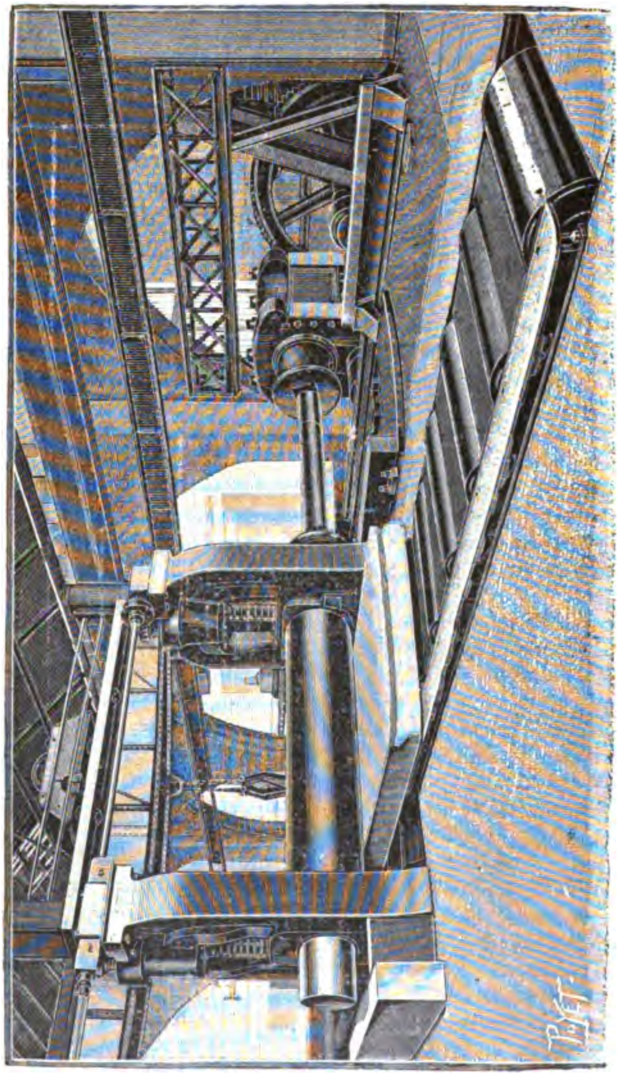
—*Scientific American*, *April* 19, 1902.

Manufacture of Armor Plate.

The manufacture of armor plate for vessels of war is much more complicated than it used to be, and comprises a certain number of successive operations. The first is that of casting the ingot which is to be transformed into an armor plate. The ingot, which weighs from 70 to 80 tons, is carried to the room containing the presses and put into the reheating furnace in order to be raised to a temperature that will permit of its form being changed. The



time necessary to effect such heating is, for large ingots, from 18 to 24 hours. The ingot is carried by a 150-ton traveling crane to the hydraulic press designed to flatten it. The large presses are huge affairs, weighing 800 tons, and of 8,000 horse power. They consist of two hydraulic cylinders 3.28 ft. in diameter with a 10-foot stroke. They are supported by cast steel cross pieces held by four forged steel columns. Such a system is sufficient for exerting a pressure of 7,150 pounds to the square inch, although in practise scarcely 5,700 pounds are exceeded. The press is actuated by steam pumps. The levers that control the press, those of the traveling cranes that support the



ingot and those for driving the different tools are placed side by side. The work can thus be performed with truly extraordinary facility. The apparatus through which the ingot is suspended is so arranged as to permit the latter to be turned over so that the two faces can be flattened in succession. With the enormous power of the hydraulic press, an ingot 4.25 feet in diameter is converted into a plate 14 inches in thickness and its length increased from 6 to 21 feet in about an hour. When the plate is to pass to the rolling mill, a length of the proper thickness is produced and its end clipped off. The plate rolling mill is a massive machine provided with two forged steel cylinders nearly 3 feet in diameter, 12 in length, and each weighing twenty tons. A steam engine actuates them at a pressure of 72 pounds to the square inch. The mill is accompanied with a traveling crane capable of lifting 60 tons. The feed rollers extend to within 42 feet of the compressing cylinders. The mill is capable of reducing a 30-inch plate to 6 inches at a single heating. The press and mill are thus capable of working four large plates a day. Upon its exit from the rolling mill the plate is cooled, and specimens are then taken from it in order to ascertain the tenacity or other properties of the metal.

The next operation is case hardening. This consists in heating two plates separated by a layer of charcoal and enveloped with bricks and sand. This system is placed in a gas furnace and submitted to a high temperature for fifteen days, at the end of which the surfaces in contact with the charcoal have had the time necessary to become sufficiently carbureted. Immediately after carburetion, the bending is done. The plate is reheated and the curvature desired is given in the large press. The plate is placed upon a wide anvil, and a matrix is made to exert its powerful action upon the upper face.

After the bending has been effected, the plate is carried to the planing room, where the final dimensions that it is to have are given to it. The planing machines employed are huge affairs. Their bed weighs 30 tons, and, as the plate weighs just as much, sixty tons are thus set in alternate motion. There are, moreover, several kinds of these machine tools, including special ones for planing the edges of the plate.

Afterward comes the operation of boring designed to perforate the plate with the holes necessary for fixing it to the hull of the ship. The holes are bored by means of small portable machines actuated through a cable or an electric motor. They are afterward reamed out. Care is taken to plug them with clay in order that they may not be injured by the subsequent operation of tempering.

The tempering requires that the plate shall be first heated to the necessary temperature. This operation is performed in a furnace analogous to those already mentioned. The plate, heated to the degree desired, is put upon an iron grate, and a sprinkling apparatus wets both of its faces. The pressure of the water is such as to prevent the formation of steam in contact with the plate, which would retard the effect of the tempering. The sprinkling lasts three hours, and during this time, no less than four or five tons of water fall upon the plate. The hardening thus produced reaches a depth of from 1 to 1½ inches.

Finally, the last operation consists in the grinding designed to give the plate its finish. The grinders are fixed upon a cast iron disk set in operation by a 30 H. P. electric motor furnishing 400 revolutions a minute. The apparatus is capable of assuming every possible inclination in order to attack all points of the plate.

Upon the whole, the various successive operations in the manufacture of a large armor plate are the following: Casting of the ingot; flattening in the hydraulic press; rolling; case hardening; bending; planing; boring; tempering, grinding. —*Scientific American Supplement, March* 15, 1902.

Press for Copper-banding Shells.

Projectiles for guns are fitted nowadays, as most of our readers are aware, with a copper driving band. This is a copper strip of a width varying with the size of the projectile, rolled or pressed into a groove made for its reception near the base of the shell. It is slightly tapered or beveled toward the front, so that it may be driven by the gas pressure into the rifling. It serves a double purpose. By engaging with the rifling of the gun it gives rotation to the projectile, and at the same time by its expansion into the bore it acts as a gas check and reduces the erosion of the gun by minimizing the escape of gas around the shell.

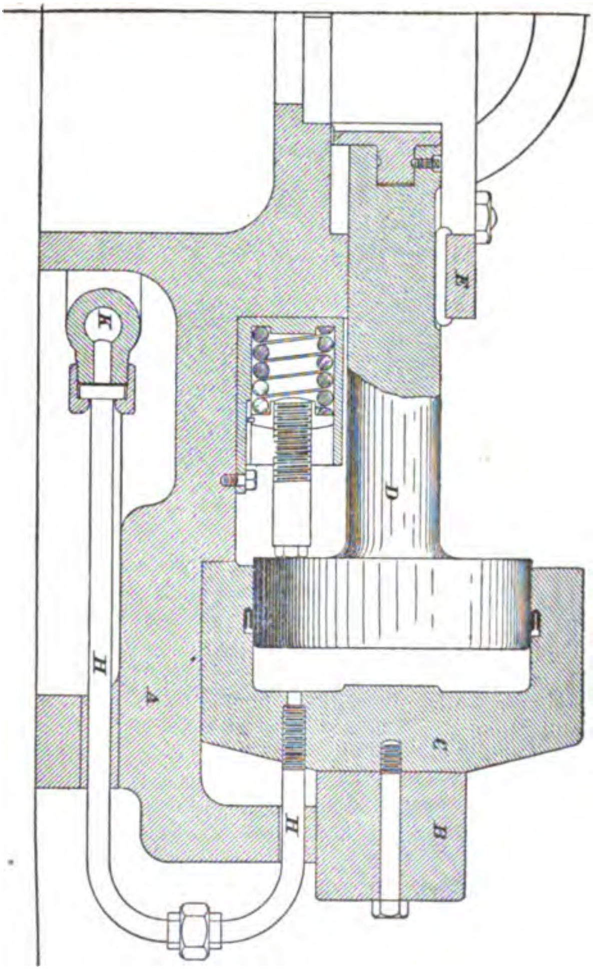


Fig. 1. Section of Press.

From these introductory remarks it will be seen that the following are the essential features of a properly fixed band: (1) it must be pressed so firmly on the shell that every portion of it is home in the groove, completely filling the undercuts, and so that the serrated projecting vees on the shell arranged to prevent the ring rotating without the projectile, are firmly embedded in the copper. (2) All the portions of the band should be equally compressed, so as to possess the same degree of density. (3) While the band must be pressed on with sufficient power to fulfill condition (1), the shell itself must not be upset enough to prevent the easy insertion of the screw gage in the fuse seat in the base of the shell.

The usual methods of forcing the bands into the grooves are either the use of a pair of semi-circular dies, brought together by a hydraulic ram, or forcing the shell through a conical die. The former method has the disadvantage of not compressing the band equally throughout its circumference; while the latter method has a tendency to cause the copper to flow toward the rear of the shell. Another objection to the use of the conical die is that the least variation in thickness of the rough copper band has a corresponding effect on the degree of tightness with which the compressed band grips the shell.

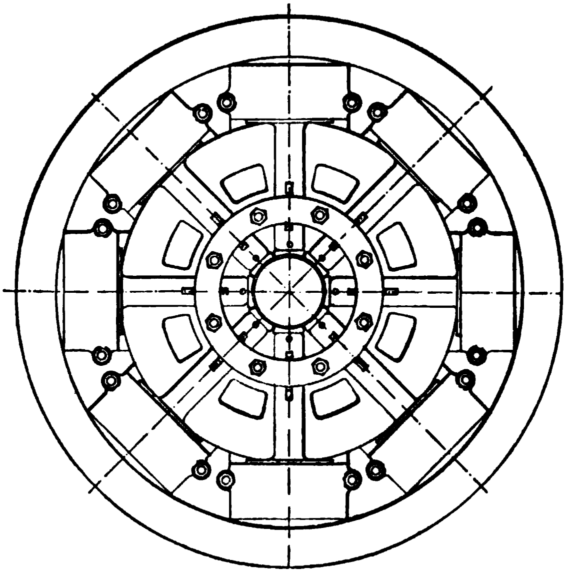
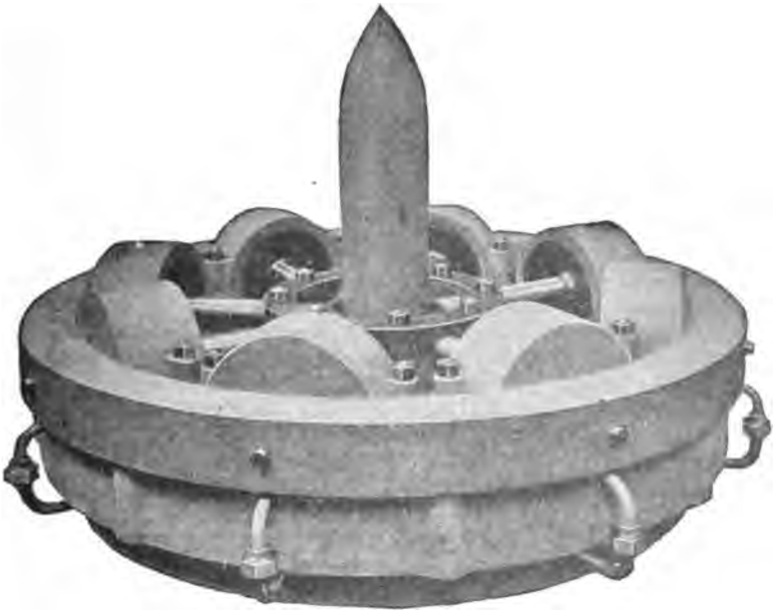


FIG. 2. PLAN OF PRESS.

In the press under notice the makers claim that the above disadvantages are conspicuous by their absence, and as this type of press is used at the shell factories, Woolwich, it would appear that the process was an advance in the right direction.

The system employed is that commonly known as "West's Patent System," in which a quantity of rams are arranged circumferentially on a bed-plate, and capable of traveling toward a common center, and the principle of the shell-banding presses will be readily understood from the photographs and drawings shown. One view is from a photograph of a press designed for

John Rogerson & Co., of Wolsingham, and made by the West Hydraulic Engineering Company, 23 College Hill, London, E. C. Shells from 4.7-inch to 12-inch caliber can be banded in this press. Fig. 2 is a plan, and Fig. 1 shows a half section taken through the center of one of the cylinders, and the following is a brief description of this size of press :



A is a strong cast iron bed plate, circular in form, supporting a weldless rolled nickel steel ring, *B*, 9 inches deep and 8 inches broad ; to the inner circumference of this ring are fixed eight steel cylinders, *C*, 15 inches in diameter, with S. M. steel rams, *D*, guided by means of a smaller ring, *E*, and carrying on their ends removable die blocks, curved to suit the periphery of the copper band. Pressure is conveyed to the cylinder by means of radial pipes, *H*, communicating with a common distributing chamber, *K*. The rams are all single-acting, and their return is effected by the springs shown, one of which is placed under each ram.

Pressure is supplied by means of a two-throw belt-driven pump, working up to 4,500 pounds per square inch when pressing the largest sized bands, but in some cases the makers supply a small intensifier instead of the pump, so as to utilize existing hydraulic pressure mains. The weight of the press in question is 12 tons. The copper rings are, of course, turned accurately to size after they are pressed on.

—*Scientific American Supplement*, *March* 15, 1900.

How Dynamite is Made.

Ordinarily dynamite can be kicked about the floor, dropped from a height, wrecked in a railroad train, set on fire and burned, all without danger. But careless handling is certain to result in catastrophe, simply because dynamite is an explosive. The factor of danger in handling dynamite increases with the increasing temperature of the commodity. It freezes at 34 deg. In that condition it is absolutely safe and can not be made to explode; in other words, it becomes a non-explosive. At 340 deg. dynamite will explode spontaneously. Between the freezing point, therefore, and the exploding point the factor of danger increases in proportion to the rise in the temperature by which the dynamite is affected.

There are eight large dynamite factories in this country, three of which are on the Pacific coast, about thirty miles from San Francisco, one in Missouri, one in Michigan and three in New Jersey. About one thousand persons are engaged in the work at the factories, and about fifty million pounds a year are turned out and shipped by rail, by boat and by wagon all over the country.

The basis of dynamite is nitro-glycerine, which is usually manufactured in the same plant as the dynamite. Nitro-glycerine is made by mixing two parts of strong sulphuric acid with one part of strong nitric acid. After the liquid has been thoroughly mixed it is cooled by being placed in a vessel around the sides of which run metal coils of pipe, through which flows cool water or cold air from a refrigerating plant. The proper proportion of mixed acid is now put into this vessel, the whole is agitated by means either of a mechanical mixer or by having air forced through it, and highly concentrated glycerine is added slowly. The temperature of the mixture must not exceed 75 deg., because heat greater than this would cause yellow fumes to arise, and the substance would decompose. A temperature of 300 deg. would cause the liquid to explode in the agitator. After the glycerine has been introduced and the whole sufficiently agitated, the mixture is run into a separate vessel and allowed to stand until the glycerine, now fully charged with nitric acid, has risen to the surface. This is nitro-glycerine. It is drawn off and washed thoroughly in water, to remove every trace of the sulphuric acid. This is done in an agitator. By a chemical process the acids are reconcentrated, and can be used again and again.

For facility in handling, the nitro-glycerine is then made into dynamite by mixing it with some combustible matter. This consists of nitrate of soda or nitrate of potash and a proper proportion of carbon. The carbon considered the best for this purpose is fine wood-pulp, which absorbs the nitro-glycerine. The absorbent of the nitro-glycerine is known in the trade as "dope," and filling this is the part of the manufacture in which the most care and skill are necessary. The absorption of the nitro-glycerine by the "dope" must be perfect, and the latter must not be surcharged so as to permit leakage. The consequences of dynamite cartridges leaking drops of such a high explosive as nitro-glycerine might be disastrous.

The percentage of nitro-glycerine used in dynamite cartridges varies from 20 per cent to 75 per cent. Of course, the higher the percentage of nitro-glycerine, the higher the explosive power. Ordinarily 40 per cent of nitro-glycerine is used in the manufacture of dynamite. Indeed, more than half of the dynamite made has this proportion. The higher grades are used in mines, and vary in intensity according to the hardness of the rock that is to be removed and the size of the vein that is being worked. In excavating the rapid transit tunnel and other similar work it is usual to employ 40 per cent nitro-glycerine.

When the fine wood pulp and other ingredients are prepared they are placed in a receptacle and nitro-glycerine is poured in, the whole mass being slowly and thoroughly stirred by mechanical mixers. Great care is taken in this work. In none of the many separated buildings that are used in the manufacture of the high explosive is iron or steel used. The mixers and all other appliances that are connected with the manufacture are of lead, so that there is no possibility of a spark or a sudden and harsh jar being produced. When the component parts have been thoroughly mixed, the substance is then put in cartridge form, being wrapped in two thicknesses of Manila paper, closed at the ends.

Each operation is conducted in a separate building, and the smallest number of workman consistent with the ready production of the compound is employed. Each man has his own particular work, and none other is allowed under any circumstances to usurp his position. This leads to special education of the employees, and permits the selection of the most intelligent. A single slip or the least exhibition of carelessness or lack of comprehension of the importance of the greatest care is equivalent to a resignation, and is acted on at once.

Made into cartridges, the dynamite is ready for the market. It is stored in a magazine, which is as far as possible removed from the next building, after having been packed in boxes, usually containing fifty pounds each. The cartridges are from ¾ of an inch to 2 inches thick, and from 4 to 8 inches long. The standard size is 1¼ inches, and is made of 40 per cent nitro-glycerine.

Shipment is made on vessels, cars and wagons, and an explosion, it is said, never occurs unless the detonating caps are with the dynamite. The manufacturers do not ship the caps and the dynamite together, preferring to send them in separate conveyances and at different times, so that by no possibility can they be brought together in transit.

Much has been said since the recent disaster in this city about the danger of carting dynamite through the streets of New York to the various storage places along the tunnel. By no possibility, according to tests that have been made, it is asserted, could any danger arise from this. In the New York office of one of the largest dynamite manufacturing concerns is a photograph of a train wreck which occurred on the Rome, Watertown and Ogdensburg Railroad near Potsdam, N. Y., on July 3, 1897. In one of the cars that was thrown off the track and torn almost to pieces were 10,000 pounds of dynamite. The wrecked car lay with its side broken and the dynamite boxes exposed, but there was no explosion.

The reason why dynamite can be handled without excessive danger to the handler, so the manufacturers say, is because the absorbent that takes up the nitro-glycerine, which is the potent factor, is elastic. The object of using kieselguhr when dynamite was invented was primarily to make the transportation of nitro-glycerine, which up to that time was extremly dangerous because of lack of facility in packing, comparatively safe. Soon it was found that there was not sufficient elasticity in this earth, and experiments were made to find a more elastic substance. Wood fiber was finally selected as the best, because it is light in weight and comparatively elastic.

The largest number of accidents with dynamite occur in the spring and in the fall. The dynamite freezes through the night when the weather is cold, and the men will not take the proper precautions in thawing it out. When you remember that it will explode spontaneously at 340 deg., what can one think of a man who will put it in front of a fire and let it stay there, or in an oven and leave it? There is only one proper way to thaw out dynamite. Put it in a room where the temperature is about 70 deg., and keep it away from the fire. Let it remain there until it has thawed out, and there will not be an explosion until the cap is placed and fired.

Dynamite is dangerous. There is enough trouble now without telling people to let down such safeguards as are maintained. Any explosive is dangerous if it is handled improperly. Dynamite will burn like a candle, only much faster, and without danger. This is because the flames eat up the stuff so quickly that the heat of them does not communicate itself to the unconsumed portion of the stick. But that is no reason why it should be tried by inexperienced persons, nor why the explosive should be set before a fire to thaw out. —*New York Tribune.*

ELECTRICITY.

Description of an Electrical Tide-indicator.*

L. Y. SCHERMERHORN.

The movements of vessels in harbors are dependent on the exact stage of water in the docks, channels, and bars adjacent to the harbor, and upon the set. or direction, of the tide at these localities. The usefulness is obvious of infallible information upon these points, available. in a convenient place, to ship owners, seamen, and others interested in the movement of vessels.

Tide tables, or the theoretic time of daily high and low water, and the height of the tide, for each day in the year, have been developed by the Coast and Geodetic Survey for all prominent points upon the tidal waters of the United States. The daily time of high and low water bears a fixed relation at each locality to the time at which the moon crosses the meridian of the place for which the tide table is calculated; while the daily relative position of the sun and moon, at the time when the moon crosses the meridian, determines the theoretic height of the tide. This interval, which would be correct but for the effect of wind and freshet, between daily high and low water, and the time at which the moon crosses the meridian, is called the "establishment of the tides."

Tide tables are invaluable guides, but they can only forecast the regular ebb and flow, and cannot foretell the changes which arise from abnormal meteorologic influences, such as the effects of floods in tidal areas, and the action of winds. For this reason the absolute tides, both in height and direction, vary greatly from the theoretic tides indicated in the standard tide tables; for example, the absolute high or low water may vary from a few tenths of a foot, to 3 or 4 feet from the theoretic height for any given day, while the time for the change of direction of the tide may vary from a few minutes to two or three hours from the theoretic time as given in the tide tables.

The tidal indicator, hereinafter described, takes all these abnormal influences into account, and its index arm moves only in consequence of changes in the water level, regardless of the cause or amount of such changes; it therefore furnishes at all times exact information as to the stage or height, and the direction, or set, of the tide, at the locality for which it records the tide.

At the instance of the Philadelphia Maritime Exchange, the United States Coast and Geodetic Survey has perfected and installed in the rooms of the Exchange in the Philadelphia Bourse, an apparatus by which the exact stage and character of the tide in the harbor can be determined at a glance, by means of a dial electrically connected with the tidal station at the foot of Chestnut Street. The tide-indicator was designed and constructed by Dr. G. Hasler, Berne, Switzerland, but in the Coast and Geodetic Survey office

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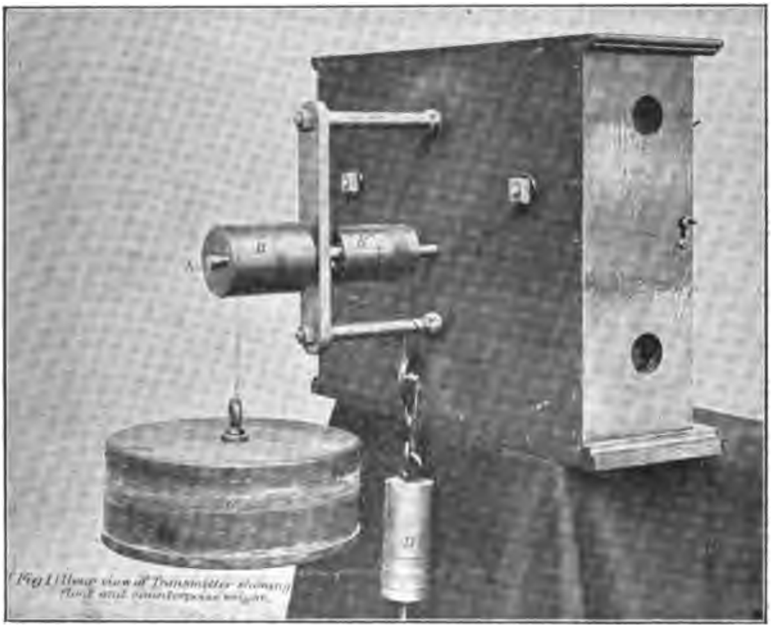
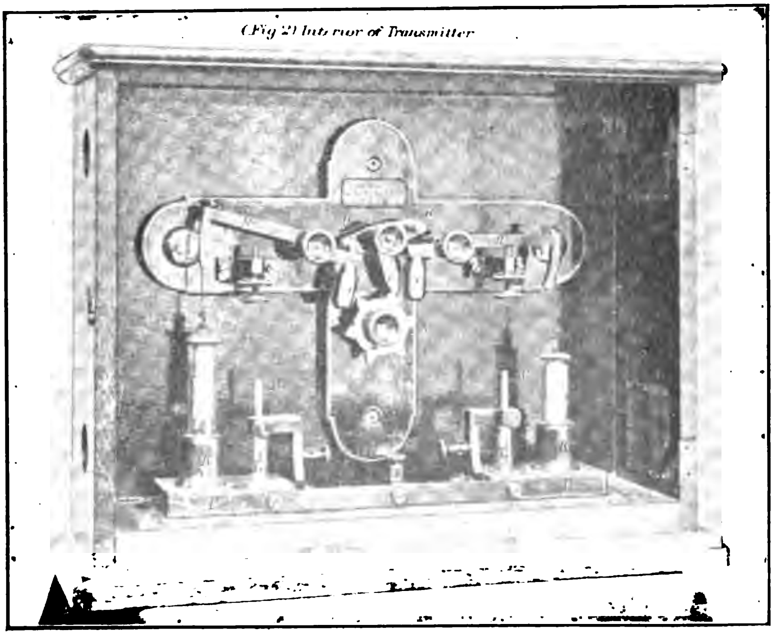
* Read November 16, 1901.



(Fig 1) Rear view of Transmitter showing float and counterpoise weight.



(Fig 2) Interior of Transmitter

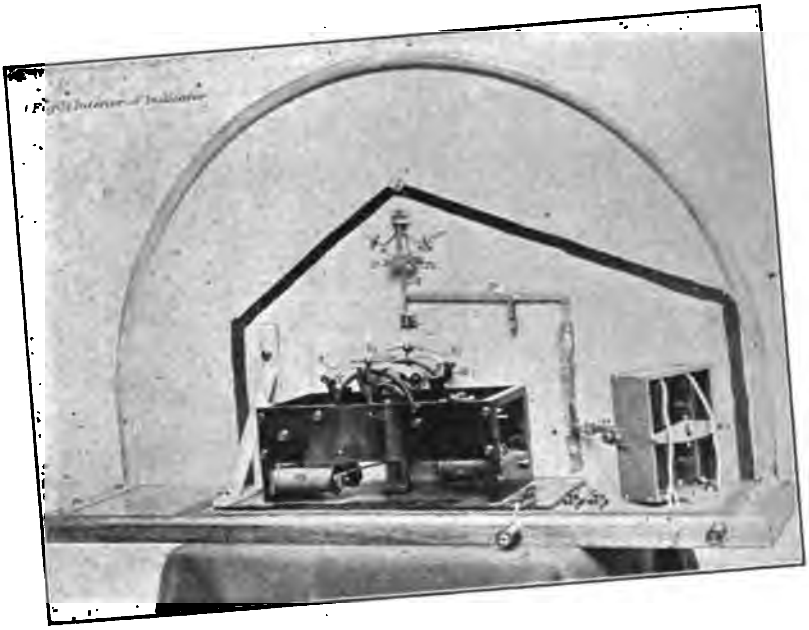


Fig. 3 Interior of Indicator

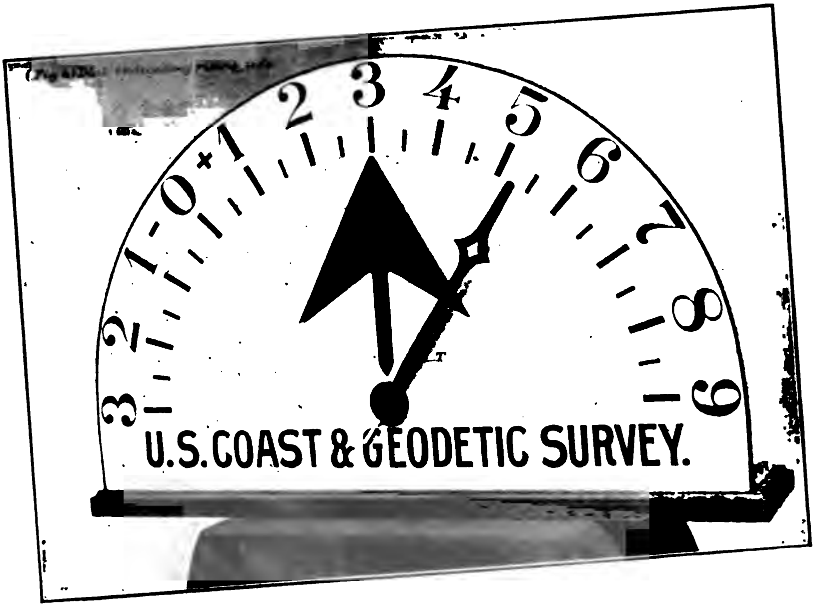


Fig. 4 Dial
3
2
1
-0
+1
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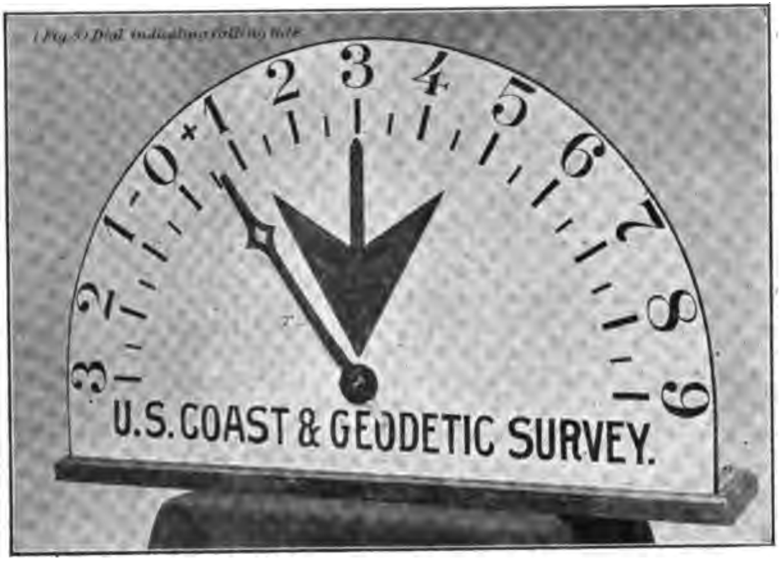
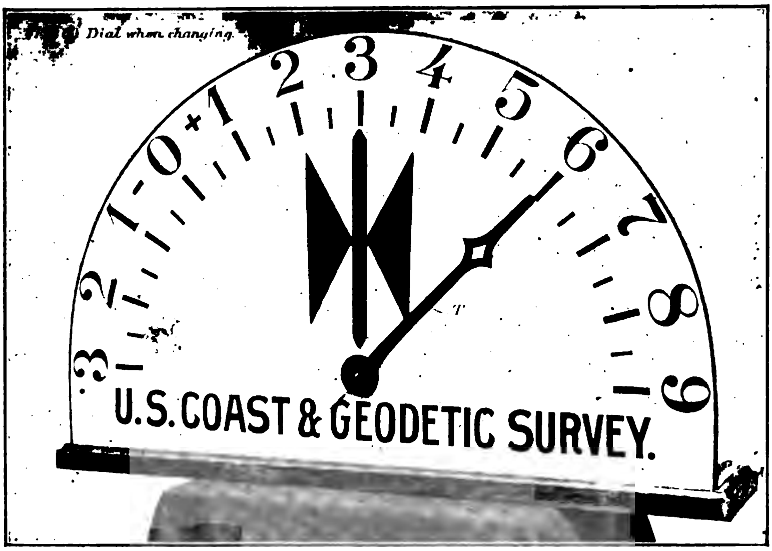
3
4
5
6
7
8
9
U.S. COAST & GEODETIC SURVEY.



(Fig. 5) Dial indicating falling tide



(Fig. 6) Dial when changing.

this apparatus has been modified, and has been supplemented by an important device due to Mr. E. G. Fischer, Chief of the Instrument Division. The original form of the Hasler indicator shows the stage of the water on the dial, but as modified by Mr. Fisher the dial not only indicates the height of the tide, but shows automatically whether the tide is rising or falling.

The Coast and Geodetic Survey has had in succesful operation for several years tide-indicators at Fort Hamilton, in New York Harbor; Reedy Island, in the Delaware River; and in San Francisco Bay. These, fitted with dials nearly 30 feet in diameter, and with figures and divisions which can be distinguished at a distance of several miles, have indicator arms that are controlled by the direct action of the changes of water level, with which they are in close mechanical connection. The indicator in the Maritime Exchange is half a mile distant from the waters the changes of which it records, and would, with sufficient battery power, represent them if a continent intervened.

The electrical tide-indicator consists of two parts, one the apparatus shown in figures 1 and 2, whereby the rise and fall of the water level is utilized to complete electric circuits which, in the second part (Figs. 3, 4, and 5), through the intervention of electric magnets, communicate the motion of the indicator arm and device by which the required information concerning the height and character of the tide is displayed to the public. The first apparatus is established in the tidal station at the foot of Chestnut Street, the second is in the Maritime Exchange, and the two are connected by properly insulated wires.

An arbor, *A*, behind the apparatus case (Figs. 1 and 2) carries two brass drums, *B* and *B′*. From *B* the float *C* is suspended, and from *B′* the counterpoise, *D*. The same arbor in the interior of the case carries the six-toothed wheel *E*. Above the ratchet wheel is placed a three-armed lever, movable about the center, *a*; the two horizontal arms carry the pins *b*, *b′*; the vertical arm *c* engages into the teeth of the ratchet wheel. The pins *b*, *b′* rest on the short arms of the levers *H*, *H′*. Resting on the bottom of the apparatus case are two iron reservoirs, *I*, *I′*, containing mercury, and which are equipped with the tubes *K*, *K′* and *L*, *L′*. In the larger tubes, *K*, *K′*, two cylinders plunge, which are suspended from the outer ends of the arm of the levers *H*, *H′*; in the smaller tubes protrude the ends of the contact rods *M*, *M′*.

If the level of the water is lowered, the float, descending, causes the wheel *E* to turn to the right, the lever *H* raising the cylinder slowly until the arm *c* trips, when the cylinder falls, compressing the air in the large tube *K*, raising the surface of the mercury in the tube *L*, and producing a brief contact with the rod *M*, thereby completing for a short time the electric circuit which brings the second apparatus into action. If the water level rises, the counterpoise *D* makes the wheel *E* turn to the left, and the mechanism on the right of figure 2, operating in a similar manner through a second circuit and set of electromagnets, produces opposite indications on the dial.

The mechanism of the apparatus in the Exchange is shown by figures 3, 4, and 5. On an arbor *UU* (Fig. 3), which carries the indicator arm *T*, two pairs of wheel, *N*, *O* and *N′*, *O′*, turn; each pair is riveted on a common barrel. A rod, fixed in the middle of the arbor *UU*, carries at one end a wheel *R*, which engages the wheels *N*, *N′*, and at the other end a counterpoise.

On the completion of the circuit in the apparatus at the tidal station (Figs. 1 and 2), if the current of the battery passes through the electro-magnet m_1 (Fig. 3), the latter attracts the armature a_1; with the interruption of the current a coil spring draws back the armature lever and the pawl k_1 makes the wheel N' advance one tooth. If the current passes through the electromagnet m, it is the wheel N which turns one tooth. The wheels N and N' are each equipped with a safety pawl t, t_1, which permit of revolution only in one direction. When the wheel N' advances one tooth, the wheel R and the arbor UU with the indicator arm T turn in the same direction, while the wheels N and O are held in repose by the pawl t. If the current passes through the electromagnet m, the wheel N turns backward one tooth and the indicator arm a space indicating a change in water level of one-tenth of a foot, while the wheels N', O' remain unmoved.

The direction of the arrow in the center of the dial (Figs. 4, 5, and 6) shows whether the water level is rising or falling. This indication is secured by the use of two electromagnets in series with m and m_1, and a system of levers which control the position of the vanes which make the head of the arrow. The electromagnet m_2 (Fig. 3) is in the same circuit with m_1, and on the completion of the circuit, in consequence of an adequate fall in the water level, attracts upward the armature o, the movement being transmitted through the various sections of the lever p to its vertical arm q, which is raised. The vanes of the arrow are fastened to two small arbors, r, r_1, to which are also attached the levers s, s_1. The levers have slots in their free ends which enclose a pin that is set in the vertical arm q. As the arm q rises in correspondence with a fall of water level, and the consequent effect upon p through the intervention of the electromagnet m_2, the slotted arms s, s_1 rise with it, revolving the arbors to which the vanes are attached and causing them to point downward as in figure 5. A rise in the water level, causing an opposite change in the movement of the various sections of the lever p, swings s and s_1 down, and causes the vanes to point upward (as in Fig. 4) by means of electromagnet m in series with electromagnet m_3.

The dial prepared for the apparatus in Philadelphia is divided so as to show the various stages of the water level from 3 feet below mean low water to 9 feet above the same plane. The indicator arm moves for every change of one-tenth of a foot in elevation. Figure 4 represents a rising tide; figure 6 shows the arm changing from a rising to a falling tide; figure 5 indicates a falling tide.

The above described electrical tide-indicator was installed on August 26, 1901, and has been in successful operation since the date named.

—*The Engineers Club of Philadelphia, January*, 1902.

A New Regulating Incandescent Lamp.

In view of the enormous extension of incandescent lighting, it is only natural that considerable attention should be paid to such regulation of the lamp as will allow its candle-power to be increased or diminished at will, as is done in the case of the gas flame. Even to-day the complaint most often heard in regard to the incandescent light is that we cannot turn it up and down as we do gas. There would certainly seem to be a very large market for a device which should permit this desideratum to be attained.

The Pinckard socket or "Tri-light" lamp is being manufactured by the Tri-light Electric Company, of Birmingham, Ala. This socket resembles in appearance the ordinary incandescent lamp socket and is operated in the familiar manner by turning the switch key. At each turn or step in the key movement a different amount of light is obtained. In the case of the double-filament lamp, which is fitted with two filaments of 8 candle power each, turning the key of the socket once throws these two filaments in series circuit and gives a light of about 2 candle-power; a second turn of the key leaves a single filament in circuit, giving 8 candle-power; a third turn throws in both filaments, giving 16 candle-power. At the fourth step both filaments are thrown out, so that no current at all is taken. It is obvious that by lowering the degrees of candle-power, an economy of current is effected. Any standard Edison base lamp can be used with the Tri-light socket, and Tri-light lamps can be used with any standard Edison socket, only one filament then giving illumination. The lamps are manufactured for candle-powers of 8, 10, 16, 32, 50 and 100.

The key socket is connected to the lighting circuit in the ordinary fashion, and this is true also of the similar wall socket. With keyless sockets holding lamps in places of inconvenient access, a special regulating switch is used, accomplishing the same purpose. Where ordinary sockets are already in use a special attachment plug is furnished which screws into the existing socket and is made with the three standard Edison, Thomson-Houston or Westinghouse devices. These new devices are all economical in purpose and should, it would seem, meet with a large demand wherever it is desired to have a light whose brilliancy can be increased or diminished at will—and there are few places where this is not the case.

—*Electrical World and Engineer*, *March*, 1902.

CHEMISTRY.

The Standard of Atomic Weights.

The ninth annual report of the committee on atomic weights, by F. W. Clarke, appears in *the Journal of the American Chemical Society* for March, 1902, Vol. XXIV, No. 3. Under the heading "Standard of Atomic Weights" the following interesting statements and data are noted:

Over this question, controversy still continues. The international committee of the German Chemical Society publishes its table for 1901 according to both standards; first with O = 16, and then in response to a demand from teachers, giving a "didactic table" based upon H = 1. Both tables are given in this report, at the end. In their third general report the same committee publish many letters from individual chemists, the final outcome from all sources being 106 voices in favor of H = 1, and 78 for O = 16. This preponderance is offset by the fact that five societies expressed their views as societies, four for O = 16, and only one for the hydrogen basis. The committee, therefore, continues to recommend the oxygen standard. The members of the Verein deutscher Chemiker who protested against the oxygen standard, also publish the results of their canvass among the teachers of chemistry in German-speaking countries, and give the name of the respondents. 104 favored the hydrogen unit; 19 preferred the oxygen standard. Erdman has printed a table of atomic weights with H = 1, which is in most points identical with that of your committee, only it is carried out uniformly to two decimal places.

Benoist, studying the "specific opacity" of substances with regard to the X-rays, finds that for the elements this property is a definite function of the atomic weight. Applying this principle to certain compounds of indium he shows that the atomic weight of that element must be 113.4 rather than 75.6. That is, the classification of indium as trivalent and not as a dyad is confirmed.

The following table of atomic weights is somewhat differently arranged from that of a year ago. First your committee gives its own list, followed by that of the German Chemical Society on the basis of H = 1. Then come the three columns, Clarke, Richards, and the German, on the standard of O = 16.

	H = 1.		O = 16.		
	Clarke.	German.	Clarke.	Richards.	German.
Aluminum	26.9	26.9	27.1	27.1	27.1
Antimony	119.5	119.1	120.4	120.0	120.
Argon	39.6	39.6	39.96	39.92	39.9
Arsenic	74.45	74 4	75.0	75.0	75.
Barium	136.4	136.4	137.40	137.43	137.4
Bismuth	206.5	206.9	208.1	208.	208.5
Boron	10.9	10.9	11.0	11.0	11.
Bromine	79.35	79.36	79.95	79.955	79.96
Cadmium	111.55	111.6	112.4	112.3	112.4
Caesium	131.9	132.	132.9	132.9	133.
Calcium	39.8	39.7	40.1	40.1	40.
Carbon	11.9	11.91	12.0	12.001	12.00
Cerium	138.0	139.	139.0	140.	140.
Chlorine	35.18	35.18	35.45	35.455	35.45
Chromium	51.7	51.7	52.1	52.14	52.1
Cobalt	58.55	58.56	59.00	59.00	59.
Columbium	93.0	93.3	93.7	94.	94.
Copper	63.1	63.1	63.60	63.60	63.6
Erbium	164.7	164.8	166.0	166.	166.
Fluorine	18.9	18.9	19.05	19.05	19.
Gadolinium	155.2	155.	156 4	156. ?	156.
Gallium	69.5	69.5	70.0	70.0	70.
Germanium	71.9	71.5	72.5	72.5	72.
Glucinum	9.0	9.03	9.1	9.1	9.1
Gold	195.7	195.7	197.2	197.3	197.2
Helium	3.93	4.0	3.96	3.96	4.
Hydrogen	1.000	1.00	1.008	1.0075	1.01
Indium	113.1	113.1	114.0	114.	114.
Iodine	125.89	125.90	126.85	126.85	126.85
Iridium	191.7	191.5	193.1	193.0	193.
Iron	55.5	55.6	55.9	55.9	56.
Krypton	81.15	81.2	81.76	81.7	81.8
Lanthanum	137.6	137.	138.6	138.5	138.
Lead	205.36	205.35	206.92	206.92	206.9
Lithium	6.97	6.98	7.03	7.03	7.03
Magnesium	24.1	24.18	24.3	24.36	24.36
Manganese	54.6	54.6	55.0	55.02	55.
Mercury	198.50	198.8	200.0	200.0	200.3
Molybdenum	95.3	95.3	96.0	96.0	96.
Neodymium	142.5	142.5	143.6	143.6	143.6
Neon	19.8	19.9	19.94	19.94	20.
Nickel	58.25	58.3	58.70	58.70	58.7
Nitrogen	13.93	13.93	14.04	14.04	14.04
Osmium	189.6	189.6	191.0	190.8	191.
Oxygen	15.88	15.88	16.000	16.000	16.00

	H = 1.		O = 16.		
	Clarke.	German.	Clarke.	Richards.	German.
Palladium	106.2	105.2	107.0	106.5	106.
Phosphorus.....	30.75	30.77	31.0	31.0	31.0
Platinum	193.4	193.3	194.9	195.2	194.8
Potassium	38.82	38.86	39.11	39.14	39.15
Praseodymium.	139.4	139.4	140.5	140.5	140.5
Rhodium	102.2	102.2	103.0	103.0	103.0
Rubidium	84.75	84.76	85.4	85.44	85.4
Ruthenium......	100.9	100.9	101.7	101.7	101.7
Samarium.....	149.2 ?	148.9	150.3 ?	150.	150.
Scandium	43.8	43.8	44.1	44.	44.1
Selenium ..... :	78.6	78.5	79.2	79.2	79.1
Silicon	28.2	28.2	28.4	28.4	28.4
Silver...........	107.11	107.12	107.92	107.93	197.93
Sodium	22.88	22.88	23.05	23.05	23.05
Strontium	86.95	86.94	87.60	87.68	87.6
Sulphur	31.83	31.83	32.07	32.065	32.06
Tantalum	181.5	181.6	182.8	183.	183.
Tellurium	126.1	126.	127.7	127.5 ?	127.
Terbium...... ...	158.8	...	160.	160.	.....
Thallium	202.61	202.6	204.15	204.15	204.1
Thorium..........	230.8 ?	230.8	232.6 ?	233.	232.5
Thulinum	169.4	170.	170.7	171. ?	171.
Tin	118.1	117.6	119.0	119.0	118.5
Titanium	47.8	47.7	48.15	48.17	48.1
Tungsten	182.6	182.6	184.	184.	184.
Uranium	237.8	237.7	239.6	238.5	239.5
Vanadium	51.0	50.8	51.4	51.4	51.2
Xenon	127.	127.	128.0	128.	128.
Ytterbium	171.9	172.	173.2	173.	173.
Yttrium	88.3	88.3	89.0	89.0	89.
Zinc.........	64.9	64.9	65.4	66.40	65.4
Zirconium	89.7	90.0	90.4	90.6	90.7

—*Journal American Chemical Society*, *March*, 1902.

WARSHIPS AND TORPEDO BOATS.

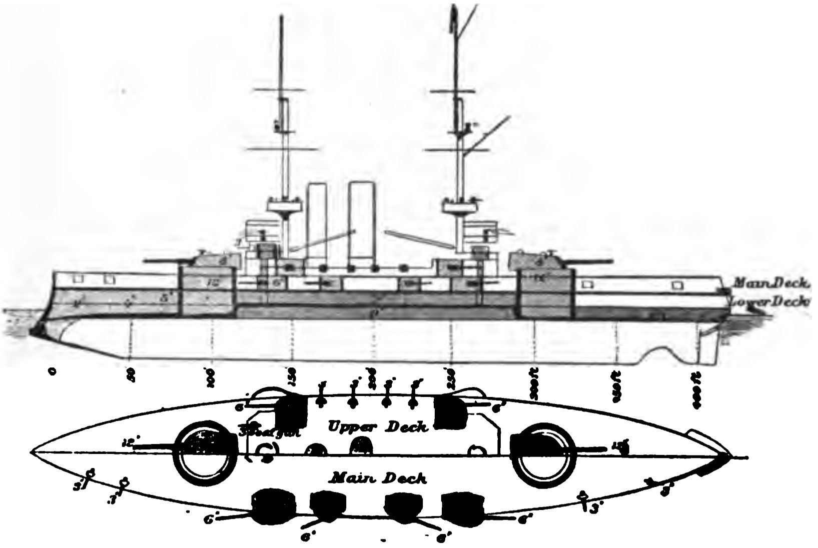
H. M. S. Queen.

On March 8, there was launched at Devonport the battleship *Queen*, a ship which is the embodiment of the latest developments in the design and construction of war ships. The *Queen* is, to all intents, a ship of the *London* class; but, being later, embodies certain improvements. These may be tabulated as follows:—(1) Limitation of ventilating cowls, which are now recognized as "shell traps." (2) Substitution of an open for closed 12-pounder battery amidships. (3) Substitution of stockless anchors for the old type anchor. In all other particulars data that apply to this ship apply with equal force to the *London* class. Particulars of the vessel are as follows:—

Displacement	15,000 tons.
Length (between perpendiculars)	400 ft.
Beam.........	75 ft.
Draft (extreme)	29 ft.

Guns: Four 12-inch wire-wound, 50 tons.
Twelve 6-inch 45 caliber Vicker's.
Sixteen 12 pounder, 12 cwt.
Two 12-pounder, 8 cwt. (boat guns).
Six 3-pounder.
Eight Maxims.
Torpedo tubes: Four 18-inch submerged.

The armor consists of a Krupp cemented belt 15 feet wide, extending from the after bulkhead to the bow. It is 9 inches thick amidships, thins to 6 inches just by the fore barbette, and thence reduces to 2 inches at the extreme bow. It is 4 inches thick at 30 feet from the stem, and here the belt proper ends. The continuation is 2 inch nickel steel, and it is carried down over the ram point, thus giving great rigidity to a weapon that no warship is likely to use. Aft of the after bulkhead, up to the level of the lower deck, there is 1 inch nickel laid on the ½ inch skin plating, constituting a species of complete belt against small projectiles—three-pounders and the like. This protection is what has been termed "naval architect's armor"—that is to say, it has probably no practical value. Those who saw the *Belleisle* after her first battering will remember how the 12-inch armor amidships on that ship is holed in places like a honeycomb where three-pounders have hit and buried themselves in it. They did not penetrate, it is true, but they went in a good deal further than the value of 1 inch, or, for that matter 2 inches of steel.



HIS MAJESTY'S BATTLESHIP QUEEN

There are two armor decks. The upper one is flat, 1 inch thick of steel where the side armor is thickest, and 2 inches elsewhere. This armor deck runs along level with the top of the belt, and forms the main deck of the ship. Its object is to prevent shell bursting on the main deck inflicting damage below that level.

The second deck is the ordinary inclined deck reinforcing the belt. It springs from the lower edge of the belt amidship, and going up at a sharp angle, has a flat top about the lower deck level in the middle of the ship. Forward and aft it sinks more, and has less curve. This particular deck is common to all our warships, from the *Majestic* class onward. The recent *Belleisle* experiments would seem to indicate that it is decidedly inferior to the French system of a flat deck below the belt, and there are grave doubts as to its efficacy, or rather as to whether the theoretical protection afforded is correct. In theory 2 inch inclined equals 4 inch vertical armor. In practice a shot falls obliquely, and so reinforces indirectly the side armor.

In theory a 9 inch belt like the *Queen's*, reinforced by a 2 inch belt, is worth as follows:—9 inch cemented Krupp × 3 = 27 inches of wrought iron; 2 inch deck × 2 inches for inclination × 2½ inches for material = 10 inches wrought iron. Total resisting value is, therefore, in theory, 37 inches of wrought iron plus the coal, which may be called another 3 inches; grand total, 40 inches. Practical value is probably nearer 30 inches, even allowing for the damage inflicted on the projectile by getting through the hard face of the outer plate. In battle, however, the ship will rarely present herself at anything but an angle to the hostile gun; this will render capped projectiles useless and increase the difficulties of others, from which it may be inferred that a 9 inch Krupp belt will keep out everything save the lucky shot at near range.

To resume. The barbettes of the *Queen* are 12 inches thick, non-cemented Krupp, equivalent in value to Harvey nickel. The turrets are Harvey nickel, 8 inches thick, inclined at an angle of about 35 degrees. Turrets of this form, we may observe, are general in every navy except the French, where the big ships adhere to vertical turrets. So far as we know, it has never occurred to anyone to submit these two rival systems to an experiment as to their relative values. Since, however, anything that hit a turret would send bolts and rivets flying inside, penetration may be of no importance, and the thickness or otherwise of the armor or its inclination alike immaterial. These turrets are avowedly for protection against small guns, and though the gun mountings of to-day embody all that human ingenuity can devise against the effect of shot, it is hardly conceivable that either guns or guns' crews will survive the fearful impact of a big projectile striking with an energy of at least 20,000 foot-tons, and possibly 30,000 to 40,000. The result seems bound to be something like hitting a clock with a hammer.

The *Queen's* secondary guns are in Krupp non-cemented casemates, 6 inches in front and 2½ inches in rear. They are situated like those of the *London*—in four rough groups of three—two on the main deck and one above between them, exposing its base to shell attack. This arrangement is supposed to lead to less "interference" than when the upper casemate is immediately above the other, as in cruisers. It is, however, a remarkable fact that all our battleships adhere to one system and all our cruisers to another. The *Drake* and *Canopus* have identical protection, so it would certainly be interesting to know why their casemates differ. Amongst naval officers there is a very strong feeling against the battleship disposition of casemates.

The machinery of the *Queen* is two sets of vertical triple-expansion engines, actuating twin screws turning inward. They are designed for 15,000 indicated horse-power, which is to give 18 knots and 110 revolutions. Steam is supplied by twenty Yarrow boilers. This will be the first use in the British Navy of a British boiler that is the only one used at all in the Austrian, Dutch, Portuguese, Swedish, and Norwegian navies—a record of sole use such as no other water-tube boiler possesses. The coal supply is 900 tons normally, and 2100 tons maximum capacity.

Arcs of fire are :—Big guns, about 130 degrees either side of the axial line; end-on casemates, 130 degrees from the axial line; other casemates, about 55 degrees before and abaft the beam. The armor weighs about 3000 tons; the weight of hull, including armor, etc , is 9985 tons. The 12-pounders are mounted, four on the main deck in the extreme bow, four distributed on the same deck aft, eight on the upper deck firing over the low bulwarks, two—the 8-cwt. "boat guns"—on the topside by the fore conning tower.

A proposal is afoot to replace some or all of the *Queen's* 6-inch guns by 7.5 pieces, and, in view of the present trend towards arming our ships as well as any possible enemies, this may very probably be attempted.

A 7.5-inch gun with mountings weighs approximately 27 tons, and its charge and projectile 256 lbs. With the new propellant some weight will be saved, and approximately 10 rounds go to the ton, and about 20 tons of ammunition are carried per gun at 200 rounds the gun. That is 240 tons for twelve guns, which, plus the weight of twelve guns and mounting—324 tons—comes to about 564 tons for an entire armament of 7.5-inch guns. To this we may add 75 tons for increased size of casemates, giving a grand total of 639 tons, which we may call 650 in round numbers. The 6-inch 45-calibers Vickers with its mounting, etc., weighs 9¼ tons. Weight for twelve guns is therefore 111 tons, against 324 tons. Ammunition runs at about 18 rounds to the ton; the total for all the secondary guns at 200 rounds we can put at 132 tons, giving a grand total of 143 tons for the present 6-inch armament, against 564 tons as an outside weight for one of 7.5-inch guns. The extra weight would then be about 421 tons.

Now, 50 tons, more or less, is a negligible weight in any of Sir William White's battleships—the margin in them being about 800 to 1000 tons in 15,000. By this we mean that all of them carry maximum coal without their speed being affected. To reduce the coal would not be politic perhaps, but the extra 420 tons odd would not very appreciably affect the speed of the *Queen*, while in any case she would consume coal enough to soon cover the difference. But the weight can be saved far more cheaply. The exact weight of "stores" carried is hard to get at, but since in dealing with a 15,000-ton total small fractions do not matter, we can arrive at an approximation sufficiently near. Something over two tons a day in the way of food, etc., are daily consumed by a battleship's crew. Much of it is in the way of food that is replenished weekly; but stores for six months are carried. If we assume these at a ton a day, we shall not probably be much more than a hundredweight or so out, and the total cannot be less than 200 tons. Probably, seeing that it includes many things beside food, 300 tons or more would be nearer the mark. Since a ship must coal at least once a month, a good three-quarters of these stores are deadweight of no value, and here alone nearly 200 tons could be saved.

Then, again, the 7.5-inch could do with less than 200 rounds. Fifty tons could be saved here. About fifty to a hundred tons of spare gear is quite unnecessary, and thus, without touching the coal, the extra 420-50 tons of 7.5-inch armament is sufficiently nearly covered to ensure no appreciable loss of speed. In addition, the 12-inch guns—each round for which weighs nearly half-a-ton—carry far more rounds than they could conceivably require. The *Queen* could not well mount more 6-inch guns than she does—save by substituting a battery *à la* Mikasa—for the main deck casemates, and that means a heavy increase in weight. Four 7.5-inch could replace four 6-inch at a cost of 160 tons, on which 10 tons of ammunition at least could be saved, and that extra 150 tons—which might conceivably be considerably less, for we have taken outside weights for the extra size of casemates—could be carried without the ship feeling it.

Our own impression is that, even did it necessitate reducing the coal supply by 400 tons, the change in armament would be a gain, for the burst of these 200 pound shells from the 7.5-inch gun is prodigious, while probable enemies all carry armor that the 7.5-inch could tackle where the 6-inch could not. There is a great deal of 5-inch armor on foreign ships, and the 7.5-inch in battle conditions should be superior to that armor, and go through it whenever it hit it seven times out of ten, while a 200-pound projectile at 2500 foot-seconds initial velocity is going to hit hard enough to make itself extremely unpleasant, even where it does not get through. Reflecting on this and kindred things, we strongly advise the admiralty to take the bull by the horns and give the *Queen* the projected 7.5-inch guns. It is a thing that can be done, and since it can be done it should be done, for it is worth it. The 6-inch gun is either too small or too large for modern requirements, and only the fact that it is the smallest gun that can be trusted to fire lyddite that will detonate with certainty justifies its use at all. Two 4.7-inch would weigh no more, and do equal execution, save with lyddite, and shoot more truly at sea. They also threaten to land us in the ***reductio ad absurdum***, for the 4-inch may be better still, and so on, till we get to the 3-pounder, the most deadly gun of any, if only its range were longer. Going upwards from the 6-inch, the 9.2-inch is barred from much employment on the score of weight, but the 7.5-inch is not, and we do not think there can be much question that fire of six 7.5's from the *Queen's* broadside would match even the two 9.2's and five 6-inch of the *King Edward.* This 6-inch would certainly fail to do.

—*The Engineer*, *March* 7, 1902.

MISCELLANEOUS.

Lythite.

BY FIRST LIEUTENANT M. J. McDONOUGH, CORPS OF ENGINEERS.

In the artillery service, attention has of late been directed largely to the want of a suitable surface for plotting boards used at the Fire and Battery commander's stations. The old paper charts though they be the best paragon, mounted on the heaviest muslin, have no duration, and almost before the drawing is completed, these large charts will shrink or expand so consideratty as to discourage all attempts at accurate work.

Numerous substitutes have been proposed, among them being celluloid, aluminum, lead etc. All these boards were so costly, however, that in the absence of an absolute, unqualified approval from all directions, money cannot be obtained for their purchase. Some competitive tests are now understood to be underway with a view to the selection of a suitable board, and from these tests we should get good results. The present subject however deals only with the surface of the board, avoiding entirely the mechanism of the plotting arrangement. When money is scarce for the purchase of such appliances, it devolves upon the artilleryman to make the best use of the material at hand, and to institute the best system possible from the available means. He will thus keep in touch with the necessities of the work and, on the adoption of the proper and expensive mechanism, he will the sooner and more intelligently handle the new materials.

So we come to the case of the plotting board, and of these a post of several batteries will need a large number. If they be of paper they will last but a short time without shrinking, and for each year's target practise, an enterprising captain demands brand new charts. Thus the recurrence of the work of constructing them becomes onerous. Sergeant Wildberger of the 15th Co., C. A. proposed in place of paper the use of a prepared paint surface, and recommended lythite cold water paint manufactured by the Frank S. De Ronde Co. The paint was tried and after a number of minor failures, it was used with the best of success. The paint is fire, weather, and water-proof, and the mixing is apparently a chemical union. Its composition is not definitely known and is understood to be a commercial secret. Explicit instructions for its application accompany the paint and the work is so simple and so absolutely satisfactory that it is surprising we were so long without it.

The best drawing-boards of dovetailed pine with hardwood ledges for contraction and expansion should be used. Such boards are now or should be at all artillery posts. In the best boards that can be produced, variations will occur, and all conditions causing a tendency toward expansion or contraction should be avoided as far as possible.

The board is sand-papered well and left with a smooth natural surface. The dry paint is then mixed with water and this is the key to the whole process. To get good results the mixing *must* be properly done. Don't put in too much water at first, and be sure that the dry powder is reduced to a thick heavy paste at the start; then you go on and gradually reduce this by the addition of small parts of water. If this is well done the paint will flow as smoothly as varnish. If not, if too much water is added, the paint will bubble and foam and this is the sign that it is unfit for use. The water has spoiled it and too much water is always death to lythite.

When the paint is properly prepared, it is applied with any suitable brush and set to dry. This takes but a short time and thereafter a new coat is applied, the brushing being in general at right-angles to that of the first coat. This is repeated for six or seven coats, the purpose being to give the surface an appreciable thickness, which then resembles a thin stone surface of about $\frac{1}{50}$″ and is very hard. The drying of the successive coats should be uniform and not too fast. Exposing in a hot Southern sun may crack the lythite in drying. Ununiform drying of the different coats causes unequal contraction with curling up in places. This is the only operation requiring skill, and, in our own case, much experimenting was necessary to produce a good surface. In case any coat cracks or curls up in some places, all loose portions should be scraped off and the surface thoroughly pumiced or sand-papered before applying a new coat. When the last coat is put on the pumice will reduce the gloss and leave a beautiful surface for drawing.

For use at stations in the open, where permanent shelters have not yet been erected, the reflection from the white surface is very wearing on the eyes and in this case, a little green or blue pigment supplied by the same concern gives the desired relief. To mix the coloring with the white, the dry paints must not be mixed. Be sure first to reduce them to liquids in the manner shown above, and then mix the liquids. Any good painter in the command will have no difficulty in applying the instructions, and when such a surface is obtained upon a heavy drawing board, the conditions causing warping or shrinking are, according to present standards, reduced to a minimum. Boards thus painted at Fort Barrancas have held for a year with scarcely appreciable change.

For draughting the surface will quickly wear out. Even 6 H pencils and steel points should be used. These sharp points scratch the surface giving any depth of line down to the faintest invisible scratch, and are admirably adapted to the purpose. With such lines we can get extreme accuracy in drawing.

Plotting boards prepared in this way and drawn on with water-proof inks are especially suited to Artillery purposes. We all know that a few days of energetic vessel tracking drill leaves a paper chart badly scored, and erasing these lines by rubbing can be done only a few times. Now a lythite board can be washed with water after drill and gives a clean board for the following day. The inked arcs will not be molested in the washing. For semi-monthly district inspections, a battery commander wants to present a clean business-like board, and with lythite it is seen to be simply a question of washing, just as if it were celluloid.

Again, the tendency of plotters to mark the position of a target by digging a point in the board is well known. In the paper or celluloid surface no amount of erasure would get these holes out. With lythite a single coat could be applied between drills, omitting to go over the arcs, and filling up all the small pencil holes. The coat is pumiced down after drying and is available for drill the next day exactly the same as when it was new.

The caution is here inserted that in preparing the paint the mixture should be strained in two thickness of very coarse muslin. If this is not done gritty particles or hard lumps will be left on the boards, which after pumicing will either not disappear or will leave holes in the surface. When ready to strain it should be of the consistency of oil paint.

When the board has been sandpapered and small holes are left in the natural surface from any cause, do not fill them with putty, but take the settling from the bottom of the paint can and apply same as for putty.

Whenever it may be desired to remove an arc or any line that has been inked on the finished surface, wet the entire line with plenty of water and while so wet, use No. 0, sandpaper on the line and it will come out readily leaving a good surface. Sandpaper must not be used for this purpose when the surface is dry because it will leave a burnished streak on the board and will not remove the line.

Washing the board always leaves the surface smooth and if a fresh coat of lythite be applied then, it will be liable to scale in places. Therefore to apply a new coat after washing, it will be necessary when the surface has become dry, to go over it again lightly with No. 0, sandpaper to give a grain to the surface so that the new coat of lythite will take firm hold. If pencil be used at all in drawing, HHH is possibly the most satisfactory.

These advantages are so simple, so appropriate to our case and so readily available that the use of the paint appeals to every one who sees it. The cost is almost nothing, something like 7 cents per lb., and 25 lbs. would paint all the plotting boards of two posts for a year.

There are many minor ways in which the use of lythite might be extended such as the painting of set-back charts, plotting-arms on boards for mortar batteries and for difference-charts where desirable.

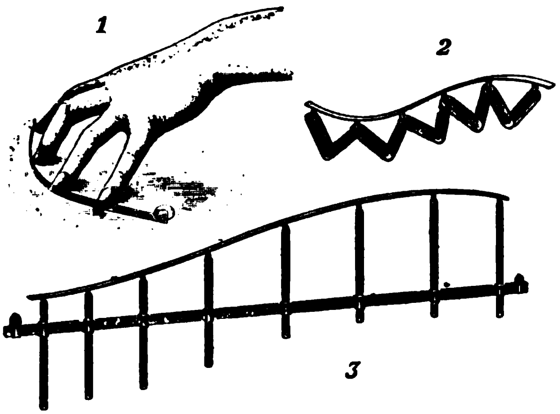
The lythite surface is undoubtedly not the best or most desirable solution of this problem, but pending the appropriation of money for the adoption of some thing better, it is so simple, so available to every one and so satisfactory in its results, that it should appeal to every one who proposes to get the best out of the means available, without waiting on others for the adoption of a final type.

Apparatus for Drawing Curves.

We illustrate herewith, from La Nature, three types of flexible rulers for drawing curves, the invention of a Mr. Brooks, of London.

One of these is made entirely of celluloid, and is provided laterally with five small rings upon which to rest the fingers when the ruler is placed vertically in order to make a drawing. It will be seen that, owing to these rings, it is possible with one hand to keep the ruler at any degree of curvature whatever, while the other hand is manipulating the drawing pen or pencil (Fig. 1).

Fig. 2. shows a similar but somewhat complicated ruler, which is here a flexible band of steel, to which, through rings, are laterally attached a series of flat links, the relative position of which determines the curves of the ruler.



The joints of these links work by hard friction, so that after any curve whatever has been given the ruler the latter keeps it until the effort necessary to modify it is made. There is thus obtained a genuine templet that permits of drawing two symmetrical curves, one on each side of the same axis.

The third type of apparatus (Fig.3) is still more complicated. Here the ruler is in most cases of wood, because it is of larger size and does not need to be so flexible. Through joints it is attached at a series of points to square metal rods that are capable of sliding in metal sockets, so as to form more or less marked concavaties in the strip of wood. The sockets, morever, are fixed upon a straight metal rod that forms, as it were, the frame of the instrument, and permits of drawing a curve on either side of a horizontal axis. As in the preceding case the apparatus may be reversed for the drawing of a symmetrical curve.

—*Scientific American Supplement, March* 8, 1902.

BOOK REVIEWS.

Kriegsgeschichtliche Beispiele des Festungskrieges aus dem deutsch-franzoesische Kriege von 1870-71. Von Frobenius, Oberstleutnant a. D. Sechstes Heft. Berlin: E. S. Mittler und Sohn. 1902. Price, 3 Marks.

The sixth number of this interesting and valuable series of studies on historical examples in the *attack and defense of fortifications* derived from the Franco-German war of 1870, treats of the Artillery Attack, especially Bombardment, illustrated by the bombardments of Diedenhofen and Montmédy by Prussian heavy guns.

The earlier numbers of this series have been previously noticed, as they appeared. It is hardly necessary to call attention again to the high value of these studies. They treat of a subject which will be of the greatest importance in any European continental war, and the great war of 1870-1 furnished some of the best examples of such attacks on fortifications. The author is well qualified for his work, not only because of his experience in war, but also because of his thorough familiarity with his subject in all details, and his literary ability.

The important and attainable are prominently separated from the unessential and problematical, and the author's clear, systematic treatment of his subject aids in emphasizing the former.

The general subject here considered is the *Artillery Attack*, and under this the particular subdivision is that of *Bombardment.* Two examples were given in the preceeding number, the third is here given, and is the bombardment of Diedenhofen and Montmédy.

The work first discusses the strategic significance of the French fortifications on the Ardennes railroad, after the battle of Metz. This railroad was designed to be the line of invasion of the French army, but due to the rapid advance of the Germans this plan was frustrated and the line lost its importance for a time. After the fall of Metz, however it became of immense importance again as a line of supply for the German armies around Paris.

The observation and seige of Diedenhofen are then considered and the bombardment, in its preparation and final execution is fully discussed.

The measures against Montmédy are then taken up, and its bombardment described in the same way,

The work is unique in the subject it covers, authoritative and reliable as a military study, well illustrated by maps and plans, thorough and comprehensive in its treatment of the subject matter, and clear and graphic in its language.

J. P. W.

Notes on Writing Orders and Reports in the Field. By Captain H. C. Evans, Adjutant 4th V. B. Manchester Regiment. London: Gale & Polden, Ltd. 1902. Pp. vi. 114. Two shillings.

This little book is one of the many interesting and valuable manuals of the "Military Series" brought out by this enterprising firm. The importance of having orders correctly framed, concise, yet conveying full information and that clearly expressed, seems self-evident, and the knowledge of how to do so should be part of the professional attainments of every officer. Nothing could be more essential to successful military operations than the mastery of this art. The history of war is strewn with catastrophes which are attributed to awkward or unintelligent orders..

Here the subject is presented in a plain, straightforward and easy manner. The author has tried to set it forth in such a way that it can easily understood and grasped, and has succeeded admirably. He has entered very fully in every detail connected with the framing, issue and transmission of orders and instructions. Commencing with a general form of divisional orders, he follows them out through Brigade and Battalion orders, including the necessary advanced guard and outposts orders and the orders issued by the officers commanding the cavalry screen, the artillery and engineers, showing how the divisional orders filter through from one unit to another. These are followed by some general remarks on orders, and then illustrated by a concrete example, with detailed forms of all the orders that would be issued by the Headquarters and the various subordinate commanding officers of two opposing forces, under conditions resulting from a general and special idea as in a War Game.

"In writing orders, one must put oneself in the place of a very poor man sending a telegram to a fool. The sender wants to make his message as short as possible, but at the same time wants to avoid any possibility of the recipient misunderstanding his meaning. In the same way orders must be as concise as possible, and yet as clear as possible. Clearness of meaning must not, however, be sacrificed for conciseness."

An instructive example from the Franco-Prussian war in another branch of orders, viz: Instructions, and some notes on transport by rail in connection with the drawing up of time tables concludes the book.

The manual is replete with information·and instructive notes, and though the book is written mainly for the volunteer officer of the British army, it should prove of use to all officers. H. Jr.

Company Training Made Easy. By Captain H. C. Evans, Adjutant 4th Vol. Bn. Manchester Regiment. London: Gale and Polden, Ltd. 1902. Pp. 86. Two shillings.

This useful manual on this important subject has been written with a view to making company training easy for both officers and the rank and file. All the subjects connected with the military efficiency of a company in the duties it may be called upon to perform in the field are considered and the author has succeeded admirably in presenting the matter in a clear, concise and direct manner.

Under such headings as Scouting, Skirmishing, Attack and Defence, Night operations, Advanced Guards, ·Outposts, Ammunition Supply in the Field, and others, the author has put together ten lectures which can be delivered to a company before putting the men through the work practically in the field. At the end of each lecture questions are given on the subject matter which not only serve to bring out the more important points, but also assist one in preparing for the lecture. The author shows thorongh acquaintance with his subject and has produced a book that ought to be of great use in theoretical and practical company instruction. H. Jr.

The Further Training and Employment of Mounted Infantry and Yoemanry. By Major General Henry Hallam Parr. 3rd Edition Revised: London: Gale and Polden, Ltd. 1902. Pp. 76, ii. One-and-Six.

Amongst the many lessons from the South African war is that of how to rate mobility in troops at its true value. In the present edition of this work, advantage has been taken of the lesson derived from this campaign to inculcate the necessity and value of masses of mobile troops.

"There is no gainsaying the fact that the General who possesses a strong body of quickly moving infantry has an increased chance of being the stronger at the important point, at the critical moment."

"Before the present war, mounted infantry was more perhaps in theory than in practice considered to be a valuable adjunct to a commander's strength; but the South African war has shown its value, and in future the Mounted Infantryman will be considered indispensable, and it will be probably found necessary to train a hundred men where ten men were, before the war, held to be sufficient." In full sympathy with the necessity for more mounted infantry and the need of its thorough and careful training, the author offers much valuable help to officers and men who may constitute such an arm. He has had much experience with mounted infantry and in the notes here put forth, he deals in a very practical manner with details affecting its organization, equipment, training and instruction, employment and duties. Many of his recommendations here given have been, moreover, practically tested on service.

H. Jr.

Trumpet and Bugle Sounds, with words. For Cavalry, Imperial Yeomanry, Royal Artillery, and Army Service Corps; Also Infantry Bugle Sounds, with words. Compiled and arranged by A. C. Atherly, Bandmaster 1st Royal Irish Regiment. London: Gale & Polden. 1902. Pp. 46. One shilling.

As the author states, this book is intended to serve a double purpose: to be of use to trumpeters, buglers and their instructors, and an aid to soldiers in learning the calls. These, on account of their number and similarity are at times confusing, especially so in the case of field calls of which no less than 96 are given in this collection. The author, to meet this difficulty, has adapted words to the various calls. Some of these are traditional, others clearly name or explain the call.

The book is quite complete, well printed and arranged and ought to be a handy help to all who have to learn and blow these trumpet and bugle sounds.

H. Jr.

Kaisertreu Wahrheitstreu? von Robert B. Jentzsch. Wien, 1902.

This pamphlet is a criticism of the work, recently reviewed in the *Journal*, entitled "Die principiellen Eigenschaften des automatischen Feuerwaffen," in which the author claims that the work just mentioned is merely an advertising medium for Roth automatic firearms and that the author thereof is the agent of the manufacturers G. Roth & Co.

J. P. W.

EXCHANGE AND BOOK NOTICES.

[Books received will be *reviewed* as space becomes available.]

The **Journal of the U. S. Cavalry Association**, in bright new dress, comes to us with this issue, and we take pleasure in welcoming its re-appearance. This number, for July 1902, is replete with matter of interest and value for the Cavalry officer. Captain Dickman entertains us with "Experiences in China," in a very interesting article, with illustrations, wherein he gives impressions of the various European forces participating in that expedition. Captain Walker relates some "Cavalry Experiences from 1898 to 1901." Other articles are: Transportation of Public Animals by Sea; Fort Washakie, Wyoming; The Automatic Fire Arm: The Revolver or Pistol best Suited to Cavalry; Molasses as a Food for Army Horses.

The **Journal** is published quarterly at Fort Leavenworth, Kansas, by the U. S. Cavalry Association. Communications should be addressed to the Secretary, Fort Leavenworth, Kansas.

Cassier's Magazine for July 1902 is an especially handsome number devoted to mining and metallurgical subjects. There are 440 pages of interesting and valuable matter pertaining to mines, plants and mining machinery in this country and other parts of the world.

Gold mining in the Transvaal, by John Hays Hammond; Copper in the United States; Canada as a Steel Producer; Coal cutting Machinery; Bessemerising Copper; Electric Locomotives in Mines; Compressed Air, Electricity and Water-power in mining; Economic Production of Iron and Steel—a partial list of the contents, gives some idea of the field covered.

The illustrations, of which there are about 235, are especially fine, beautifully reproduced and add greatly to the appearance of the volume.

The Popular Science Monthly for August contains articles on two subjects that naturally lend themselves to discussion at the present time. Professor Burr, of Columbia University, and engineer of the Isthmian Canal Commission, gives an account of the Panama route for the canal—that on which Congress has decided—and Dr. T. A. Jaggar, of Harvard University, describes the disasters at St. Vincint and Martinique. Dr. Jaggar was one of the first zoologists to visit the islands and to ascend to the craters, and his stay was longer than that of others.

Professor Burr compares the Panama and Isthmian Canal routes and thus summarizes the possibility of danger from volcanic disturbances: The recent volcanic eruptions on the Island of Martinique indicate a possible danger to the Nicaragua canal, should it be built, from the living volcano of Ometepe in Lake Nicaragua about ten miles from the land line. That there is some danger is beyond question, but it is very remote. There is no evidence to show that a canal or canal structure ten miles distant from Mont Pelee would have been injured by its recent eruptions, although navigation might have been interrupted for a short time. It is an open question, therefore, whether Ometepe in most violent eruption, even, would injure the Nicaraguan Canal, although danger would exist. On the other hand, as there is no volcano within about 175 miles of the Panama route, that route would be free from all danger of volcanic eruption.

For beauty and wealth of illustration, to say nothing of interesting subject matter of current interest, we have seen nothing more attractive than the August number of the **World's Work**. It is a vacation number with one hundred illustrations which charm the eye by their artistic excellence. An article of especial interest is *West Point After a Century*, by Frederick Palmer, well written and fully illustrated by pictures of many and various phases of Cadet life and routine, and of incidents of the recent Centennial Celebration. Other subjects treated are *The People at Play* profusely illustrated: *How Labor is Organized; Will Our Commercial Expansion Continue?; The Nature and Field of Trust Companies; New York to Chicago*—20 *Hours.*

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INDEX TO CURRENT MILITARY LITERATURE.

PERIODICALS CITED.

Abbreviations employed in index are added here in brackets.

All the periodicals are preserved in the Artillery School Library, Fort Monroe, Virginia.

ENGLAND.

Aldershot Military Society. *Occasional.*
Aldershot. Copies 6d each.

Arms and Explosives. [*Arms and Ex.*] *Monthly.*
Effingham House. Arundel Street, Strand, London, W. C. Per year 7s.

Army and Navy Gazette. [*A. and N. Gaz.*] *Weekly.*
3 *York Street, Covent Garden, London. Per year £1 12s 6d.*

Canadian Military Gazette. [*Can. Gaz.*] *Fortnightly.*
Box 2179 *Montreal, Canada. Per year* $2.00.

The Engineer. [*Eng.*] *Weekly.*
33 *Norfolk Street, Strand, London. Per year £2 6d.*

Engineering. [*Eng'ing.*] *Weekly.*
35-36 *Bedford Street, Strand, London, W. C. Per year £2 6d.*

Journal of the Royal United Service Institution. [*Jour. R. U. S. I.*] *Monthly.*,
22 *Charing Cross, Whitehall, London, S. W. Per year* 24 *s.*

Journal of the United Service Institution of India. [*Jour. U. S. I. India*] *Quarterly.*
Simla, India. Per year $2.50.

Photographic Journal. [*Photo. Jour.*] *Monthly.*
66 *Russell Square, London.*

Proceedings of the Institution of Civil Engineers. [*Proceedings I. C. E.*]
25 *Great George Street, Westminister, London.*

Proceedings of the Institution of Mechanical Engineers.
[*Proceedings I. M. E.*] 19 *Victoria Street, Westminister, London.*

Proceedings of the Royal Artillery Institution. [*Proceedings R. A. I.*] *Monthly.*
Woolwich, England.

Professional Papers of the Corps of Royal Engineers.
[*Prof. Papers Corps Royal Eng'rs.*] *Chatham, England.*

Review of Reviews. [*Rev. of Rev. Austral.*] *Monthly.*
169 *Queen Street, Melbourne, Australia. Per year* 11 s. 6 d.

Transactions of the Canadian Institute. [*Trans. Canadian Inst.*]
58 *Richmond Street, Toronto, Canada.*

Transactions of the Canadian Society of Civil Engineers.
[*Trans. Canadian Soc. C. E.*]
Montreal, Canada.

Transactions of the East of Scotland Tactical Society.
[*Trans. E. of S. Tactical Soc.*]
51 *Hanover Street, Edinburgh, Scotland.*

Transactions of the Institute of Naval Architects.
[*Trans. Inst. Naval Architects.*]
5 *Adelphi Terrace, London, W.C.*

United Service Gazette. [*U. S. Gaz.*] *Weekly.*
10, *Wine Office Court, Fleet Street, London, E. C. Per year* £1 10 *s* 6 *d.*

United Service Magazine. [*United Serv. Mag.*] *Monthly.*
13 *Charing Cross, S. W. London. Per year* 27 *shillings.*

FRANCE.

Armée et Marine. [*Armée et Mar.*] *Weekly.*
3 *Place du Théatre Français, Paris, France.*

Le Génie Civil. [*Génie C.*] *Weekly.*
6 *Rue de la Chaussée d Antin, Paris. Per year* 45 *Fr.*

Le Livre Militaire. [*Livre Mil.*] *Monthly.*
6 *Rue de la Chaise, Paris. Per year* $1.00.

La Marine Française. [*Marine F.*] *Semi-monthly.*
26 *Rue de Grammont, Paris. Per year* 30 *Fr.*

Mémoires et Compte Rendu des Travaux de la Société des Ingénieurs Civils.
[*Ingénieurs Civils.*] *Monthly.*
10 *Cité Rougemont, Paris. Per year* 36 *Fr.*

Mémorial des Poudres et Salpêtres. [*M. Poudres et S.*] *Quarterly.*
Quai des Grands-Augustins, 55, *Paris. Per year* 12 *Fr.*

Le Monde Militaire. [*Monde.*] *Fortnightly.*
6 *Rue de la Chaise, Paris. Per year* 8 *Fr.*

Revue d'Artillerie. [*R. Artillerie.*] *Monthly.*
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Revue des Questions Militaires. [*Quest. Mil.*] *Monthly.*
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Le Yacht—Journal de la Marine. [*Yacht.*] *Weekly.*
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GERMANY.

Allgemeine Militaer-Zeitung. [*A. M.-Zeitung.*] *Semi-weekly.*
Darmstaadt. Per year 24 *M.*

Beiheft zum Militaer-Wochenblatt. [*Beiheft.*]
Koch Strasse, 68, *S. W., Berlin.*

Illustrirte Aeronautische Mittheilungen. [*Aeronaut. Mitth.*] *Quarterly.*
Kalbgasse 3, *Strassburg i. E. Germany. Per year* $1.70.

Internationale Revue. [*Int. Revue.*] *Monthly.*
Blasewitzer Strasse 15, *Dresden. Per quarter* 8 *Fr.*

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Mohren Strasse, 19, *Berlin, W.* 8. *Per year* 32 *M.*

Kriegstechnische Zeitschrift. [*Kriegstech.*] *Ten numbers a year.*
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Mittheilungen ueber Gegenstaende des Artillerie und Genie-Wesens.
[*Mitth. Art. u. G.*] *Monthly.*
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Mittheilungen aus dem Gebiete des Seewesens. [*Seewesens.*] *Monthly.*
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Organ der Militaer Wissenchaftlichen Vereine. [*Vereine.*]
Wien I, Stauchgasse No. 4 *Per year,* 8-14 *numbers,* 6 *Fl.*

Zeitschrift des Oesterreichischen Ingenieur und Architekten Vereines.
[*Z. Architek. Ver.*] *Weekly.*
I. Eschenbachgasse, No. 9, *Wien. Per year* 10 *Fl.*

SWITZERLAND AND BELGIUM.

Allgemeine Schweizerische Militaer-Zeitung. [*A.S.M. Zeitung.*] *Weekly.*
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La Belgique Militaire. [*Belgique M.*] *Weekly.*
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Monatschrift fuer Offiziere Aller Waffen. [*Monatschr.*] *Monthly.*
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Revue de l'Armée Belge. [*A. Belge.*] *Bi-monthly.*
22 *Rue des Guillemins, Liege, Belgium. Per year* 13 *Fr.*

Revue Militaire Suisse. [*R. M. Suisse.*] *Monthly.*
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Schweizerische Militärische Blätter. (Including *Schweizerische Zeitschr. für Art. u. G.*, and *Monatschr. für Offiziere aller Waffen*).
[*Schweiz. Mil. Blaetter.*] *Monthly. Frauenfeld, Switzerland.*
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Annaes do Club Militar Naval. [*Club Mil. Nav.*] *Monthly.*
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Boletin Militar. [*Boletin, Mexico.*] *Weekly.*
Calle de San Rafael 2821, *Mexico. Per year* $6.00.

Circulo Naval,—Revista de Marina. [*Circulo Naval.*] *Monthly.*
Casilla num. 852, *Valparaiso, Chili.*

Memorial de Artilleria. [*M. de Art.*] *Monthly.*
Farmacia, num. 13, *Madrid, Spain. Per year, U. S.*, $3.40.

Mexico Militar. [*Mex. Mil.*] *Monthly.*
City of Mexico, Mexico. Per year......

Revista Cientifico-Militar. [*Cientifico M.*] *Semi-monthly.*
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Revista de Engenheria Militar. [*Engenheria Mil.*] *Monthly.*
27 *Rua Nova do Almada, Lisbon, Portugal. Per year* 1 $ 800 *réis.*

Revista de Infanteria. [*R. Infanteria.*] *Monthly.*
Rua de S. José, 30–32, *Lisbon. Per year* 1 $ 200.

Revista del Club Militar. [*R. Club Mil.*] *Monthly.*
Calle de Suipacha No. 383, *Buenos Aires. Price per year* $ $^{m}/_{n}$ 15.00.

Revista del Circulo Militar. [*R. Circulo Mil.*] *Monthly.*
Calle de Suipacha No. 383, *Buenos Aires, Argentina. Per year* $ $^{m}/_{n}$ 15.00.

Revista do Exercito e da Armada. [*Exercito.*] *Monthly.*
Largo de S. Domingos No. 11, *Lisbon, Portugal. Per year U. S.* $6.00.

Revista General de Marina, [*R. G. de Marina.*] *Monthly.*
56 *Calle de Alcalá, Madrid, Spain. Price U. S.* $4.45.

Revista Maritima Brazileira. [*R. Marit. Brazil.*] *Bi-monthly.*
Rue do Conseheiro Saraiva n. 12, *Rio de Janeiro, Brazil. Per year* $1.575.

Revista Militar. [*R. Mil. Portugal.*] *Semi-monthly.*
262 *Rua da Princeza, Lisbon, Portugal. Per year*, $2.60.

Revista Militar. [*R. Mil. Brasil.*] *Monthly.*
Rio de Janeiro, Brasil. Per year

Revista Militar y Naval. [*R. Mil. y Nav.*] *Semi-Monthly.*
Calle Colonia, No. 379 *A. Montevideo, Uraguay.*

HOLLAND AND SCANDINAVIA.

Artilleri-Tidskrift. [*Art. Tids.*] *Bi-monthly.*
Artillerigärden Stockholm, Sweden. Per year, U. S., $1.75.

De Militaert Gids. [*M. Gids.*] *Bi-monthly.*
De Erven F. Bohn, Haarlem, Holland. Per year, U. S., $2.00.

Militaert Tidsskrift. [*M. Tids.*] *Bi-monthly.*
Copenhagen, Denmark. Per year, U. S., $2.50.

Norsk Artilleri-Tidsskrift. [*N. Art. Tids.*] *Bi-monthly.*
Christiania, Norway. Per year $1.50.

Norsk Militaert Tidsskrift. [*N. M. Tids.*] *Monthly.*
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RUSSIA.

Artilleriiskii Journal. [*Rus. Art. Jour.*] *Monthly.*
Furschtatskaia Ulitza, St. Petersburg, Russia.

Razviedchik. [*Rasv.*]
KoloKolwaia Ulitza, No. 14, *St. Petersburg, Russia.*

Russkii Invalide. [*Invalide.*]
Wadizdinskia Ulitza, No. 48, *St. Petersburg, Russia.*

Voyennyj Sbornik. [*Rus. Voy. Sbo.*] *Monthly.*
Madezhcdinskoi Dom. No. 21, *St. Petersburg, Russia. Per year* 4.80.

ITALY.

Rivista di Artiglieria é Genio. [*R. Artig.*] *Monthly.*
Tipografia Voghera Enrico, Rome. Per year 30 *L.*

La Corrispondenza. [*Corrispondenza*]. *Monthly.*
1 *Rue de Rome, Livorno, Italy. Per year* $5.00.

Rivista Marittima. [*R. Maritt.*] *Monthly.*
Rome. Per year 25 *L.*

UNITED STATES.

American Electrician. [*Amer. Elec.*] *Monthly.*
120 *Liberty Street, New York. Per year* $1.00.

American Journal of Mathematics. [*Jour. Math.*] *Quarterly.*
John's Hopkins University, Baltimore, Md. Per year $5.00.

American Machinist. [*Amer. Mach.*] *Weekly.*
256 *Broadway, New York City. Per year* $3.00.

American Manufacturer and Iron World. [*Man. and Iron World.*] *Weekly.*
55 *Ninth Street, Pittsburgh, Pa. Per year* $4.00.

Annual of the Office of Naval Intelligence. [*Naval Intelligence.*]
Washington, D. C.

Army and Navy Journal. [*A. and N. J.*] *Weekly.*
New York City. Per year $6.00.

Army and Navy Register. [*A. and N. R.*] *Weekly.*
Washington, D. C. Per year $3.00.

Bulletin of the American Mathematical Society. [*Bulletin Math. Soc.*]
University Heights, New York City. Ten numbers per year. $5.00 *per year.*

Cassier's Magazine. [*Cas. Mag.*] *Monthly.*
3, *West 29th Street, New York City. Per year* $3.00.

Electrical World and Electrical Engineer. [*Elec. Eng.*] *Weekly.*
9 *Murray Street, New York City. Per year* $3.00.

Electrical Engineering. [*Elec. Eng'ing.*] *Monthly.*
Monadnock Block, Chicago, Ill. Per year $1.00.

Electrical Review. [*Elec. Rev. N. Y.*] *Weekly.*
41 *Park Row, New York City. Per Year* $3.00.

The Engineer. [*Eng. Cleve.*] *Fortnightly.*
Blackstone Building, Cleveland, Ohio. Per year $2.50.

Engineering Magazine. [*Eng'ing. Mag.*] *Monthly.*
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Engineering News and American Railroad Journal. [*Eng'ing News.*] *Weekly.*
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Engineering and Mining Journal. [*Eng. and Min. Jour.*] *Weekly.*
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The International Monthly. [*Int. Montly.*] *Monthly.*
Burlington, Vt. Per year: $3.00.

The Iron Age. [*Iron Age.*] *Weekly.*
232-238 *Williams Street, New York City. Per year* $4.50.

Journal of Electricity. [*Jour. Elec.*] *Monthly.*
421 *Market Street, San Francisco, Cal.*

Journal of the American Chemical Society. [*J. Chem. S.*] *Monthly.*
Easton, Pa. Per year $5.00.

Journal American Society of Naval Engineers. [*A.S.N. Egrs.*] *Quarterly.*
Navy Department, Washington, D. C.

Journal of the Association of Engineering Societies. [*Eng. Soc.*] *Monthly*
257 *South Fourth Street, Philadelphia. Per year* $3.00.

Journal of the Franklin Institute. [*Frank. Inst.*] *Monthly.*
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Journal of the Military Service Institution. [*Jour. M. S. I.,*] *Bi-monthly.*
Governor's Island, New York City. Per year $4.00.

Journal of the U.S. Cavalry Association. [*Jour. U. S. Cavalry*] *Quarterly.*
Fort Leavenworth, Kansas.

Journal of the Western Society of Engineers. [*W. Soc. Eng.*] *Bi-monthly.*
1737 *Monadnock Block, Chicago, Illinois. Per year* $2.00.

Marine Review. [*Mar. Rev.*] *Weekly.*
Cleveland, Ohio. Per year $2.00.

Military Information Division. [*Mil. Information Div.*] *Occasional.*
War Department, Washington, D. C.

Mines and Minerals. *Monthly.*
Scranton, Penn. Per year $2.00.

New South. *Monthly.*
Nashville, Tenn. Per Year $1.00.

Notes on Naval Progress. [*Naval Intelligence.*] *Occasional.*
Navy Department, Washington, D. C.

The National Guardsman. [*N. Guard,*] *Monthly.*
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Pennsylvania Magazine of History and Biography. [*Penn. Mag. of Hist.*], *Quarterly.*
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The Photographic Times. [*Phot. Times.*] *Weekly.*
60 *and* 62 *E.* 11*th Street, New York City. Per year* $5.00.

Physical Review. [*Phys. Rev.*] *Ten numbers per year.*
Cornell University, Ithaca, New York. Per year $5.00.

Popular Science Monthly. [*Pop. Sc. Mo.*] *Monthly.*
72 *Fifth Avenue, New York City. Per year* $5.00.

Popular Mechanism. [*Pop. Mech.*] *Weekly.*
Journal Building, Chicago, Ill. Per year $1.00.

Proceedings of the American Philosophical Society.
[*Proceedings of A. Phil. Soc.*]
104 *South Fifth Street, Philadelphia, Pa.*

Proceedings of the American Society of Civil Engineers.
[*Proc. A. S. Civil Engr's.*] *Monthly.*
220 *West* 57*th Street, New York City.*

Proceedings of the Engineers' Club of Philadelphia. [*Eng. C. Phila.,*]
Quarterly.
1122 *Girard street, Philadelphia, Pa. Per Vol.* $2.00.

Proceedings of the U. S. Naval Institute. [*Naval Inst.*] *Quarterly.*
Annapolis, Md. Per year $3.50.

Review of Reviews. *Monthly.*
13 *Astor Place, New York City. Per year* $2.50.

The Scientific American. [*Scien. Amer.*] *Weekly.*
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Shooting and Fishing. *Weekly.*
293 *Broadway, New York City. Per year* $3.50.

The Spanish War Journal. [*Span. War Jour.*]. *Monthly.*
320 *Indiana Ave., Washington, D. C.* $1.00 *per year.*

Technology Quarterly. [*Tech. Quart.*] *Quarterly.*
Mass. Inst. of Tech., Boston, Mass. Per year, $3.00.

Telephone Magazine, Illustrated, [*Telephone Mag.*] *Monthly.*
Marquette Building, Chicago, Ills. Per year $1.00.

Transactions American Institute of Electrical Engineers.
[*Inst. Elec. Eng'rs.*] *Monthly.*
26 *Cortlandt Street, New York City. Per year* $5.00.

Transactions American Institute of Mining Engineers.
[*Trans. Inst. Min. Eng'rs.*]
99 *John Str., New York City.*

Transactions of the American Society of Civil Engineers.
[*Trans. A. S. Civil Eng'rs*]
220 *West* 57*th Street, New York City.*

Transactions of the American Society of Mechanical Engineers.
[*Trans. A. S. Mech. Eng'rs.*]
12 *West* 31*st Street, New York City.*

Transactions of the Society of Naval Architects and Marine Engineers.
[*Naval Architects and Marine Eng'rs.*]
12 *West* 31*st Street, New York City.*

Texas Volunteer Guard. [*Tex. Vol. Gd.*]. *Monthly.*
Hillsboro, Texas. $0.50 *per year.*

United Service. [*U. Serv.*] *Monthly.*
49 *Wall St., N. Y. City. Per year* $3.00.

Western Electrician. [*West. Elec.*] *Weekly.*
510 *Marquette Building, Chicago, Illinois. Per year* $3.00.

World's Work. *World's Work. Monthly.*
34 *Union Square East, New York City. Per year* $3.00.

ARTILLERY MATERIAL.

Carriages:

Carriage for new German 15-pdr. Q. F. Field gun.—**Eng.**, May 16.
Düsseldorf Exhibition, Krupp Carriages.—**Eng'ing.**, June 6.
Schneider field carriage.—**Art. Tids.**, March-April, 1902.
Are disappearing guns (carriages) essential to the efficient defense of our seaports.—(Ruckman).—**Jour. Mil. Serv. Inst.**, July.
Shields for field artillery guns, and their influence on tactics.—**A. S. M. Zeitung**, June 21.
Opinion of General Rohne on field guns with deformation mounts.—**M. de Art.**, May.
Disappearing carriages.—**Schiffbau**, May 8.

Explosives:

Monograph of new powders.—**R. Marit.**, Brazil, January.
A new powder, smokeless and noiseless.—**A. and N. Gaz.**, July 5.
A new Portuguese smokeless powder.—**U. S. Gaz.**, July 5.
German powder manufacture.—**Int. Rev.**, Supplement 39, June.
Complaints against cordite.—**S. Zeitschr.**, April.
How dynamite is made.—**Jour. U. S. Art.**, July-August.

Guns:

New Italian field artillery material.—**R. Artillerie**, June.
History and present position of the field howitzer.—**U. S. Mag.**, June.
The Cullen ball bearing gun.—**Pop. Mech.**, June 14.
The Düsseldorf exhibition. Krupp guns.—**Eng'ing.**, June 6.
Premature explosions of Q. F. guns.—**A. and N. Gaz.**, June 7.
Field gun tests at Fort Riley.—**A. and N. Reg.**, June 21.
The Mondragon gun.—**Mitth. Art. u. G.**, June.
Researches concerning the most important principles of construction of our future projectile throwers, guns, field howitzers.—**Art. Tids.**, April-May.
Schneider field guns.—**Art. Tids.**, March-April 1902.
Modern artillery.—**R. Marit.**, Brazil, March.
Rapid fire and machine guns.—**R. de Art.**, March.
Armstrong rapid fire guns.—**C. M. Naval**, May.
The new Krupp rapid fire field gun with hydraulic brake.—**R. Circulo Mil.**, February.
Results of firing tests of the Krupp R. F. mountain guns.—**R. M. Suisse**, June.
The Sims-Dudley dynamite gun.—**Armee et Marine**, June 15.
New Austrian field howitzer.—**U. S. Gaz.**, June 21.
History of present position of field howitzer.—**U. S. Mag.**, July.
Short study on the rifling of cannon.—**M. de Art.**, May.
Artillery material at the Düsseldorf exposition of 1902.—**Kriegstech Z.**, June.
Classification of automatic fire arms.—**Cientifico M.**, May 15.

Rearmament of Italian field artillery.—**Wochenblatt,** April 30.
Gun foundries.—**Int. Rev.,** Supplement 39, June.
Hotchkiss machine gun.—**Kriegstech Z.,** May.
Some interesting features of the Krupp Works at Essen.—**Jour. U. S. Art.,** July-August.
Equipment of 75 mm. rapid fire field gun.—**M. de Art.,** April.
The new Italian field artillery, 75 H.—**R. Artillerie,** May.
Field and position artillery material, from Schneider & Co.—**Art. Tids.,** April-May, 1902.
Captain Dunn on the Manufacture of War Material in Europe and in the U. S.—**Int. Rev.,** Supplement 39, June.

Projectiles:

Capped shot.—**Eng.,** May 30.
Düsseldorf exhibition, Krupp projectiles.—**Eng'ing.,** June 6.
Capped armor-piercing projectiles.—**Eng.,** June 27.
Capped projectiles.--**Iron Age,** July 10.
Press for copper-banding shells.—**Jour. U. S. Art.,** July-August.
Ammunition for 10.5 cm. guns.—**M. de Art.,** July.

Range and Position Finders:

Gronssellier's stereoscoptic telemeter.—**R. Marit.,** Brazil, January.
Defects of the Bar and Stroud telemeter.—**Circulo Naval,** April.
A rustic telemeter.—**R. Artillerie,** May.
A method of measuring distances without a range finder.—**R. Artig.,** May.
Triangle for telemetric calculations.—**Jour. U. S. Art.,** July-August.

AUTOMOBILES, BICYCLES, AEROSTATION.

The Severo navigable balloon.—**Eng.,** May 16.
Use of the bicycle in several European armies.—**Mil. Tids.,** 1-2, Heft, 1902.
Motor war car.--**Jour. R. U. S. Inst.,** May.
The bicycle in field hospital service.—**Kriegstech. Z,.** 5.
History of aeronautics.—**Genie M.,** May.
Use of balloons in South Africa.—**Belgique M.,** May 18.
The Tractor, a heavy traction engine.—**Scien. Amer.,** June 28.
Liquid air automobiles.—**Pop. Mech ,** June 28.
A new type of air ship. (Barton).—**Jour. R. U. S. I.,** June.
Use of balloons in the Boer war.—**R. Mil.,** Portugal, May 15.
The artillery bicycle.—**R. Circulo Mil.,** January.
Trials of heavy weight automobiles in England in 1901.—**R. Artillerie,** May.
Automobilism from a military point of view.—**R. Inf.,** June.
Sims motor war car.—**Pop. Mech.,** July 12.
Automobiles from a military point of view.—**A. and N. Gaz.,** July 5.
Steam wagons in military service.—**Eng'ing.,** July 4.
History of aerostation.—**Genie M.,** June.

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Exterior:

Vertical projection of the trajectory.—**R. Mil.,** Brazil, February 1902.
Computation of particular range tables from general range tables. (Tables for particular guns and mortars).—**Mitth. Art. u. G.,** June.
The law of accidental deviation.—**Mitth. Art. u. G.,**May.

Penetration and Armor:

A new Krupp armor.—**Eng.,** May 16.
Armor and guns of fighting ships.—**Cas. Mag.,** June.

Guns vs. armor-plates.—**Eng'ing.**, May 30.
Artillery vs. armor.—**Eng'ing.**, May 30.
Armor plate defeated.—**U. S. Gaz.**, June 7.
Guns and armor.—**A. and N. Gaz.**, June 14.
Armor plates at the Düsseldorf exhibition.—**Eng'ing.**, June 13.
Gun and armor plate trials at Barrow.—**Jour. R. U. S. I.**, June.
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Resumé of the principal experiments made with armor.—**M. de Art.**, May.
On the fire of projectiles charged with high explosives against armor plates. —**R. Maritime**, June.
Armor plates pierced with Johnson capped projectiles.—**Iron Age**, July 10.
Present status of armor and armor plate.—**Eng. News**, July 17.
Krupp armor plate exhibition.—**Mar. Rundschau**, July.
Krupp armor plate—Düsseldorf exposition.—**Int. Rev.**, Supplement 23, May.
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Late developments in ordnance and armor.—**Jour. U. S. Art.**, July-August.
Manufacture of armor plate.—**Jour. U. S. Art.**, July-August.
Shields for limbers.—**Mitth. Art. u. G.**, May.

CHEMISTRY AND PHOTOGRAPHY.

Physico-chemical appliances in the navy.—**R. Maril.**, Brazil, April and May.
The standard of automic weights.—**Jour. U. S. Art.**, July-August.
Anti-corrosive paints; their qualities and composition.—**Eng'ing.**, June 27.
A continuous electric blue printing apparatus.—**Eng. News**, June 5.

DRILL REGULATIONS, MANEUVERS AND PRACTICE.

English new infantry regulations.—**A. and N. Gaz.**, May 24.
Firing regulations of Swiss infantry.—**Beilage, A. S. M**, II Heft.
Drill regulations of the French field artillery, 1901.—**N. Art. Tids.**, January.
Grand naval maneuvers, 1902.—**Mar. Rev.**, June 12.
1901 years Russian field service rules seen particularly from an artillery point of view.—**Art. Tids.**, March-April, 1902.
Exercises, or training with light batteries, prepared for the field.—**Art. Tids.**, March-April, 1902.
Infantry drill regulations (Argentina).—**R. Circulo Mil.**, January.
The navy and the French maneuvers of 1902.—**Yacht**, June 14.
The Japanese army in the great maneuvers of 1901.—**Cercle**, June 21.
The new provisional drill regulations for French field artillery.—**R. Artig.**, April.
Latest from the French drill regulations and maneuvers.—**Wochenblatt**, July 2.
New rules for inspection of firing practice in the Russian army.—**Wochenblatt**, July 2.
Drill regulations and firing instructions for machine gun division.—**Wochenblatt**, July 5.
Summer maneuvers of the Russian army, 1902.—**A. S. M. Zeit.**, July 5.
Instruction of artillerists and torpedo forces.—**Club Mil. Naval**, July.
Target practice (on battle scale) of the Russian field artillery.—**S. Monatschr.**, April.
Firing regulations of Swiss infantry.—**A. S. M. Zeit.**, Beilage II.
The Russian maneuvers of 1902.—**Wochenblatt**, May 31.
Polo.—**Wochenblatt**. June 4.

The new and preceeding infantry drill regulations.—**Vereine,** 4.
The *attack* under the old and the new drill regulations.—**Vereine,** 4.
Target practice of Russian field artillery.—**Mitth. Art. u. G.,** 5.
Instruction in riding.—**S. Monatschr.,** April-May.
A new French infantry drill regulations.—**S. Monatschr.,** May.
Plotting board for mortars.—**Jour. U. S. Art.,** July-August.
Firing mortars at moving objects.—**Jour. U. S. Art.,** July-August.
Manual for 12-in. B. L. mortar.—**Jour. U. S. Art.,** July-August.
Method of laying guns in which the fire direction is placed in the hands of the fire commander.—**Jour. U. S. Art.,** July-August.
Coast artillery target practice in U. S., in England, in Russia, in France.—**N. Art. Tids.,** January.
New German garrison regulations.—**Cercle,** June 7.
Remarks on target practice of field artillery.—**N. Art. Tids.,** January.
Exercises, or training with light batteries prepared for the field.—**Art. Tids.,** March-April, 1902.
Fire of modern field artillery.—**M. de Art.,** March.
Problem in shrapnel fire.—**M. de Art.,** April.
New French method of gun fire by General Rhone.—**M. de Art.,** April.
Rapid fire with field guns.—**M. de Art.,** April.
Indirect fire of field artillery.—**Exercito,** April.
Notes on the new fire regulations for field artillery.—**Belgique M.,** June 8.
In regard to the new firing regulations for field artillery.—**Belgique M.,** June 22.
Firing Regulations of the German field artillery,—**Int. Rev.,** July.

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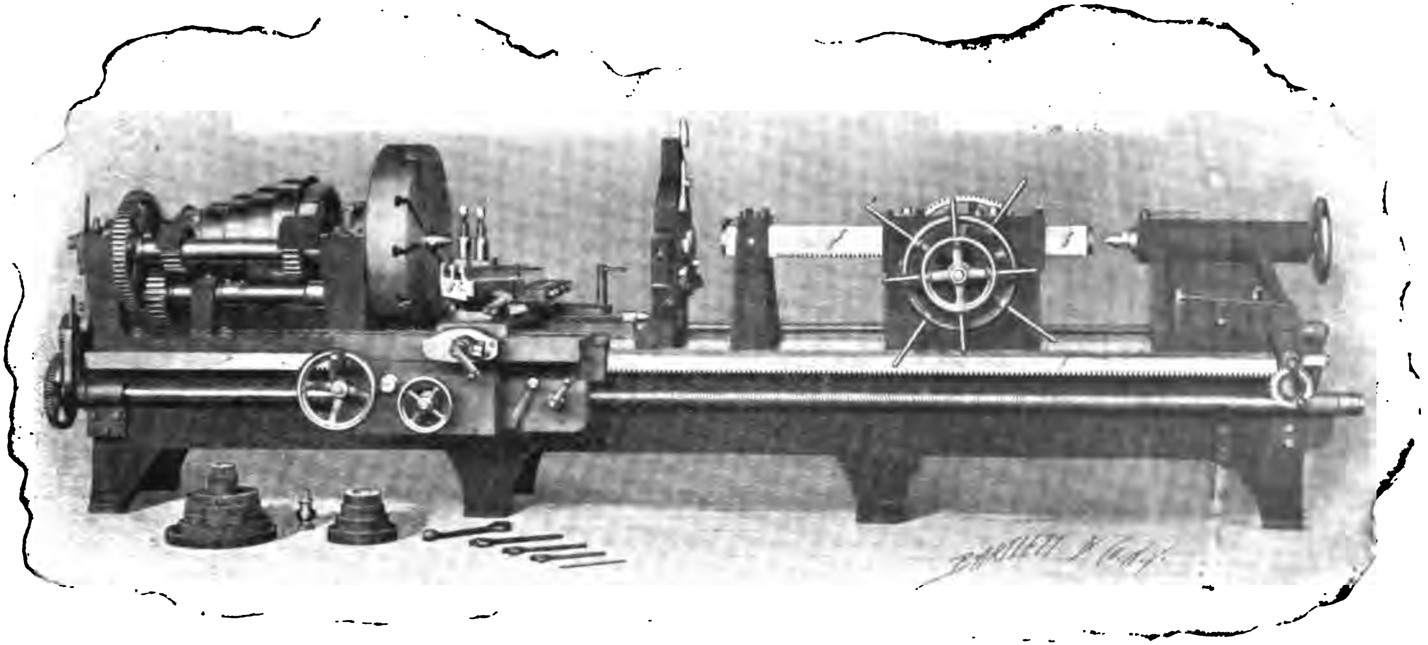

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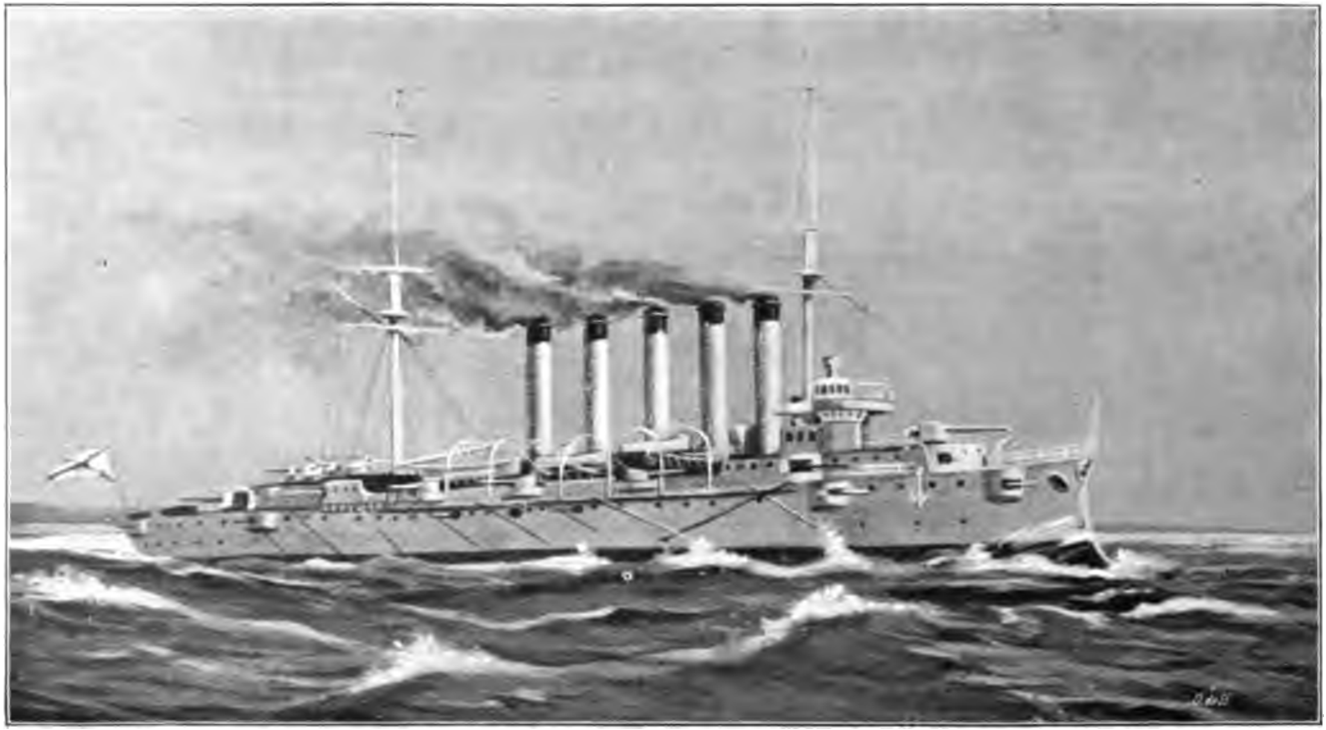

The Russian Cruiser "Askold".

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Vol. XVIII. No. 2. SEPTEMBER—OCTOBER 1902. Whole No. 57.

REPORT ON THE MOUNTS AND MEANS OF AMMUNITION SUPPLY AT THE R. F. GUN BATTERIES AT FORT PICKENS AND FORT McREE, FLORIDA.*

Communicated by the Chief of Artillery, U. S. A.

The Board of Officers constituted by S.O. No. 81, Headquarters Department of the East, dated April 10, 1902, to test the mounts and means of ammunition supply at the rapid fire gun batteries at Fort Pickens and Fort McRee, Fla., submitted the following report:

Pursuant to the above mentioned order, the Board met at Fort Barrancas, April 27, 1902, and proceeded to examine the batteries and their armament.

The rapid fire battery at Fort Pickens is part of Battery Cullum and consists of two 4.724-inch Armstrong rapid fire guns on automatic, center pivot, pedestal naval mounts.

Ammunition is supplied solely by hand. The difference of level between the magazine floor and the loading platform is eleven feet and the distance from the magazine door to the gun, about twenty-seven feet, communication being by means of stairs seven feet wide.

Battery center at Fort McRee consists of four Driggs-Seabury, 15-pdr. rapid fire guns, on balanced pillar mounts. There are no cranes, ammunition being supplied solely by hand. The difference in level between the magazine floor and the loading platform is nine feet, and the distance about twenty-eight feet. The communicating stairs are five, six and seven feet wide.

The accompanying sketch shows the form of target adopted, which consisted of canvas screen supported by a raft and towed by the Quartermaster's steamer "General French."

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* Published by permission of the Lieutenant-General Commanding.

The test of the batteries took place April 23d, beginning at 3 p.m. Two sighting shots were fired from the 4.724-inch guns at Fort Pickens, the range being 1300 yards. Both fell short. Twenty-eight shots were then fired as rapidly as possible with each shot aimed.

The error in the number of shots fired in the series (28 instead of 30) was due to a misunderstanding on the part of the non-commissioned officer in charge of the magazine.

The gun detachment consisted of one sergeant, two corporals and ten privates. The ammunition was cast-iron shell and black pebble powder, the powder case and projectile being separate. Electric primers were used, and no misfires occurred. Two slight interruptions due to the extraction of empty shells occurred, the time so lost being deducted from the time of firing the series. The corrected time was six minutes and fifty-six seconds. Eighteen hits were made as shown on the accompanying diagram, the errors of the misses being in elevation only.

With the exception of a little lost motion in the elevating gear, present before firing and amounting to about nine minutes, no defects were observed in the mount which was found to be in good condition after the firing, and to have changed only five minutes and forty-five seconds in level when gun elevating device was placed at a zero reading. Greater rapidity of fire could doubtless be obtained with smokeless powder; for the smoke blew directly in the gunner's eyes and delayed the aiming, which might otherwise have been completed during the loading of the piece. No ammunition was on the platform at the beginning of the test, the supply being begun at the command "Load." The supply was in excess of the requirements at all times.

The test of the 15-pdr. battery was conducted in a similar manner, the range being 1100 yards, the speed of the target something less than three miles per hour owing to a strong head tide, the ammunition being fixed, with cast-iron shell and smokeless powder. The detachment consisted of one corporal and five privates.

Two sighting shots were fired, both falling short. Thirty shots were then fired in five minutes and fifty-one seconds, sixteen hits being made. The last seven were misses, being fired by a new gunner, the first being disabled by the concussion. All misses were caused by errors of elevation.

The Board deems it proper to invite attention to the severity of the concussion which seriously affected the efficiency of the detachment. It is thought that if no means of protection can

be provided, the men should be frequently relieved during action. The empty shells were found to be heated by the discharge to such a temperature as to make handling difficult. It is thought that two pairs of non-conducting gloves should be included in the equipments for this gun.

No defects developed in the mount, which, after the firing, was readily lowered to the masked position and again raised for firing.

The operation of opening and closing the breech prevent the gunner from holding his sight on the target. It is not practicable during rapid firing at a moving target to use the clamps provided because two extra men are required, and their positions are so exposed to concussion as to seriously interfere with their hearing the necessary commands for clamping and releasing to enable the gunner to follow the target. It is suggested that a clamp operated by the foot of the gunner after the manner of the foot brake of a hoisting engine would obviate the difficulty described.

The supply of ammunition was in excess of the requirements at all times.

The Board is of the opinion that the mounts of both types of rapid-fire guns are satisfactory with exceptions noted, and that the means of ammunition delivery provided in the two batteries tested is adequate.

A SET-BACK CHART FOR MORTARS.

BY CAPTAIN H. G. BISHOP, ARTILLERY CORPS.

This set-back chart was devised for use with the 12-inch mortar battery at Fort Adams, R. I., and has been used with considerable success by the 79th Company, Coast Artillery. Its principal recommendations are that it is easy to operate, that there is no crowding of converging lines and that it shows the set-back for a complete set of powder charges.

In the plate herewith, illustrating this chart, ranges for every hundred yards are found along the upper and right hand edge of the chart. The lines drawn across the sectors and marked 200, 300, etc., represent the speed of the target in yards per minute.

The operator sets the fiducial edge of the arm *CH* at the given range and reads the set-back in yards from the scale on the arm at the point where the given speed line intersects it. For example: Using a powder charge of 50.5 lbs. B.P. powder (M.V. 800 f.s.) the set-back for a range of 5600 yards, speed of target 700 yards per minute, is 446 yards. With a speed of 550 yards per minute the set-back would be 350 yards.

CONSTRUCTION.

Having assumed a series of powder charges with their corresponding muzzle velocities, compute the set-back for a target having a speed of 900 yards per minute for every 100 yards of range. From a common center draw a sector for each M.V. assumed, the angular extent of any sector being roughly proportioned to the difference between the greatest and least ranges for which the particular M.V. is applicable. At *C*, the center of the sectors, pivot an arm whose edge *CH* is graduated to any convenient scale, say 30 yards to the inch. Referring to the drawing herewith and to the second sector from the bottom, which is constructed for a M.V. of 1000 f. s. the limits of range for which are 7200 and 8800 yards, lay off on *CF* by means of the scale on the arm *CH*, the computed set-back *CD* for a range of 7200 yards, speed of target 900 yards per minute; on *CG* lay off *CE* the computed set-back for a range of 8800 yards, speed of target 900 yards per minute. Draw *DE*. Divide *CD* into nine equal parts and through the points of division draw lines across the sector parallel to *DE*. These nine parallel lines are

the speed lines for speeds of 100, 200, 300, etc. yards per minute.* Draw *FG* at a convenient distance beyond the 900 yard speed line. Lay the arm *CH* so that *DE* cuts its fiducial edge at the computed set-back for a range of 7300 yards, speed of target 900 yards per minute, and mark where the fiducial edge of *CH* cuts *FG*; similarly lay the arm so that it reads the set-back for 7400 yards of range and mark the point on *FG* and so on for each 100 yards increase in range up to 8800 yards.

Each of the other sectors is constructed in a similar manner.

---

* As an aid to the eye, these lines are drawn in black, and the parallel lines for subdivisions of each 100 yards are in red.

A PREDICTING AND SET-BACK RULER.

BY FIRST LIEUTENANT P. C. HAINS, JR., ARTILLERY CORPS.

In any system for predicted firing the important considerations must always be rapidity, facility and reasonable accuracy. Hence the less complicated any such system can be made the greater will be its success.

With this object in view my Predicting and Set-Back Ruler has been devised.

By doing away with the set-back chart and computing the set-back point graphically from the ruler, the complication of apparatus is shortened by one step, and time is also saved, while the accuracy of the computation has in no way been lessened.

The ruler consists of the ordinary scale (200 yards to one inch) reading to 10 yards, for measuring the distance travelled by the target in one minute.

Immediately under this scale is the *speed curve*, whereby the speed of the target in yards per second can be read at a glance, for any given travel during a minute interval.

The predicting end of the ruler (of double scale) is essentially the same as in any ruler of this kind except that the ten yard intervals on this scale are subdivided by dots so that it may be used directly to plot the set-back point without removing the ruler and still maintain the least reading of ten yards for this purpose.

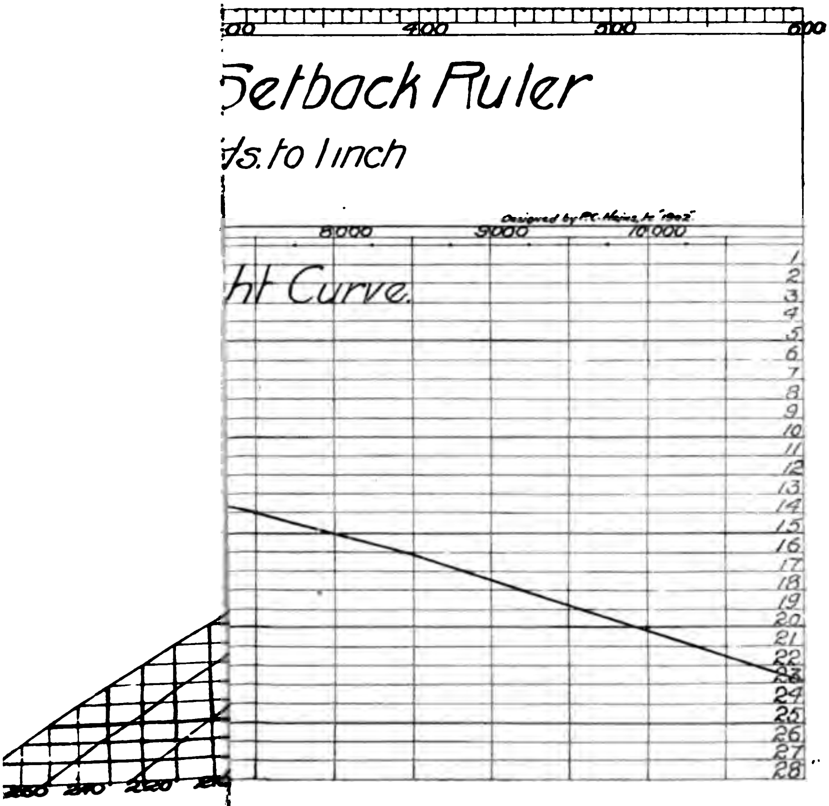
Immediately below the speed curve and throughout the entire length of the ruler is the time of flight curve, for a given gun and muzzle velocity.

At the origin of the curve is a graphic *set-back table*, the radial lines numbered 1, 2, 3, etc. to 10 representing the speeds of target in yards per second, while their intersection with any horizontal line representing the time of flight for a given range, gives the product of the two in yards (or the set-back), which is read on the scale numbered from 0 to 280 at the bottom.

As an illustration, using the 12″ B.L.R., M.V. 2025 f.s.; suppose the plotted positions of the target showed it had travelled 240 yards in one minute. 240 yards is at once plotted at the predicting end of the ruler, for the predicted point, and its range estimated approximately by placing the range arm of the plotting board near it, without interfering with the ruler.* Sup-

---

* A difference of as much as 500 yards in range alters the time of flight so little that an approximation taken in this way is amply close, and a saving of time is affected by not moving the ruler. On the other hand the utmost accuracy may be used if so desired.



00
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600
Setback Ruler
ds. to 1 inch
Designed by P.C. Hains, Jr. 1902.
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2240
2230
22

pose the estimated range is 8000 yards. Now directly under the 240 yard interval on the ruler, the speed curve shows the target to be moving at the rate of four yards per second.

Notice the horizontal line cut by the time of flight curve at 8000 yards range, (it is seen to be line number fifteen), and follow out to where this line intersects line number four on the set-back table. Read this distance directly at the bottom of the table. It is found to be sixty yards, which is the set-back sought. (15 secs. × 4 yds. per second = 60 yds. set-back.)

It is readily seen that the eye may rapidly take in approximations including both fractions of seconds in time of flight, and fractions in speed in yards per second.

Thus let the speed be 4½ yards per second and the time of flight 14⅓ seconds. An imaginary horizontal line one-third the way between lines fourteen and fifteen (time of flight curve), intersects an imaginary radial line one-half the way between lines four and five (set-back table) at a point which dropped to the bottom scale is about half-way between 60 and 70, say 65. (14⅓ × 4½ = 64.485). This is seen to be within about one-half yard of the true value.

In running out the intersection of the time of flight line with the speed line, it is only necessary to note the numerical value of the speed line, since it is the position of the time of flight line, not its numerical value that influences the reading of the result.

A fully equipped ruler would of course have two scales as indicated above, one on one side for targets moving out, and one on the other side for targets moving in, the latter being of course drawn in the reverse direction.

A white celluloid face with the lines in colors would greatly help the eye to rapid reading, while a velum surface on that part intended to receive the time of flight curve would enable these curves to be put in at anytime, erased or otherwise altered as desired.

FIGHTING BOOKS.

By Captain A. E. BUTCHER, R.A.

Extract from Minutes of *Proceedings Royal Artillery Institution*. Vol. XXIV, 1897.

INTRODUCTION.

"Garrison Artillery Drill (1895)," Vol. I., p. 476, lays down:— "That each C.R.A. of a district, will, during peace time, elaborate in principle and detail a system for fighting his command."

The vital importance of the above paragraph can hardly be overrated, as the most usual form of attack to which a modern coast fortress (and more especially one protecting a channel which leads to an inner harbor) is liable, is that known as "running past" and, in resisting such a form of attack the fort will be called upon to engage ships moving at rates varying from 14 to 20 knots an hour, according to the facilities, or the reverse, offered by the channel to reasonably safe navigation.

Even taking the lower limit:—"The time from an enemy's ship being first sighted until its arrival within fire, will—even in day time—be less than half-an-hour; at night, far less. Supposing the hostile ships are a quarter of a mile apart they will arrive within a minute of each other. Each ship will, as a rule, be under the fire of each fort only 15 minutes at the outside."*

It would be quite impossible under such circumstances for a battery commander in the heat and excitement of action to give detailed orders as to projectiles, etc., for each particular class of ship at each particular range, and, in order to avoid dire confusion, such details must be worked out previously.

After an approaching hostile ship has been identified and her description passed to the G.G.C.'s, these officers should know, without any further instructions, the most suitable projectile with which to attack her at the various ranges, and the whole system of fighting the fort should proceed like clockwork with a minimum of orders.

Unless a regular system of fighting a fort has been worked out, down to the smallest detail, in time of peace, and unless such a system has been continually practiced at drill, we may find ourselves placed in the humiliating position of seeing a hostile ship pass our fort practically unharmed.

---

* G.A.D. (1895), Vol. I., p. 488.

The "Garrison Artillery Drill," Vol. I., indicates the lines on which such systems of fighting forts are to be based, but so far as I know, no complete specimen of a "Fighting Book" has yet been published.

I venture, therefore, to suggest the following form of "Fighting Book" as containing sufficient information in a concise form to enable a coast fort to be fought to the best advantage. In order to carry out the principle that when actually fighting his fort the B.C. should not be burdened with any matter not dealing directly with the best method of inflicting the greatest amount of damage, in the shortest possible space of time, on the hostile vessel opposed to him, the book has been divided into two parts.

Part I. contains a summary of useful information regarding the fighting powers of the fort. This part will necessarily vary considerably according to local circumstances, that given in the specimen book being only intended as a guide.

Part II. deals with the fort "in action." In this part it will be noticed that each form of attack—with its corresponding "detail of projectiles"—is dealt with on one double page, so that a B.C. has all his information before him at once.

Parts I. and II. should be bound together in the form of a book for easy reference.

With regard to part I., it may be objected that the information contained therein should form part of the "Fort Record Book"[*]—and so it should—but by embodying it also in a "Fighting Book," which is being constantly consulted at drill, there is less likelihood of its being overlooked.

The only point in the "Fighting Book," which requires any special explanation here is the system of classification adopted for indicating the class of ship approaching the fort, as it may appear, at first sight, to differ from that contained in the drill-book. The divergence is, however, more from the letter than from the spirit of the authorized system, as the following will show.

All navies, from the point of view of a coast fort, naturally fall into the following five classes, viz :—

I.—Heavy ironclads	Signal one.
II.—Medium ironclads	Signal two.,
III.—Light ironclads (including gun-boats)	Signal three.
IV.—Cruisers	Signal four.
V.—Torpedo boats and light craft	Signal five.

---

[*] G.A.D. (1895), Vol. I., p. 452.

Simplification for any individual fort can therefore be obtained by arranging locally the classes of ships noted in the identification sheets under the above named groups according to the power of the guns with which the fort is armed in the following manner:—

(*a*) Ships carrying belt armor beyond the power of the heaviest guns mounted at ranges over 500 yards being classed as "Heavy."

(*b*) Ships carrying belt armor beyond the power of the heaviest guns mounted at ranges over 2000 yards being classed as "Medium."

(*c*) All other ironclads (including gun-boats) being classed as "Light."

This classification for ironclads appears to be quite minute enough for all practical purposes, as all ships beyond the power of certain guns at the above ranges would have to be dealt with similarly by those guns—*e.g.*, Classes A, B, C, D, E, F, G, H,* being beyond the power of the 10″ B.L. above 500 yards would all have to be attacked by "secondary or shell attack" and can therefore all be, with advantage, classed as "heavy" for those forts whose most powerful gun is the 10″ B.L.

The numerical signals have been adopted to prevent confusion with those contained in the identification sheets and are, moreover, applicable to the ships of any nation.

In order to make the specimen "Fighting Book" more realistic, it is supposed to be made out for a fort mounting the following armament:—

A Group	2, 10″ B.L.
B "	2, 12.5″ R.M.L.
C "	2, 6″ B.L.
D "	2, 6 pr. Q.F. Hotchkiss
E "	2, 3 pr. Q.F. Hotchkiss
Movable Armament . . .	2, 40 pr. R.M.L. 3, 3 Bar. Nordenfeldt

and covering a narrow passage leading from the open sea to a sheltered harbor beyond. The fort is fought by D.R.F., no position finder being installed.

---

* Identification sheets.

MEMORANDUM.

The instructions contained in this book are, under *ordinary circumstances, to be rigidly adhered to;* it is, however, to be distinctly understood that, in exceptional cases, *Battery Commanders are expected to use their own judgment as to changing the nature of projectile,* when such a course is evidently indicated, reporting the fact of their having done so to the fire commander.

The system herein laid down is to be continually practiced at drill, so as to insure all ranks to be thoroughly conversant with the method of fighting the fort.

(By order)

....Captain, R.A.,
Instructor in Gunnery,
..............................Defences.

REFERENCES.

A.P. means *Armor Piercing Shot* (Steel or Palliser, according to the gun).

C.P. " *Common Shell, Percussion fuze.*

S.T. " *Shrapnel Shell, Time fuze.*

S.P. " *Salvo Points.*

FORT X.

BATTERY COMMANDER'S FIGHTING BOOK.

PART I.

ARMAMENT.

Description.	Groups.	Number and Nature.	How Mounted	Remarks
Primary	A	2 10″ B.L., Mark II.	H.P. mount'g.	Fought by G.G.C.
	B	2 12.5″R.M.L., Mark I.	En Barbette	
	C	2 6″ B.L., Mark IV.	H.P. mount'g.	
Secondary	D	2 6-pr. Hotchkiss	Cone mount'g	
	E	2 3-pr. Hotchkiss	Cone mount'g	
Movable		2 40-pr. R.M.L.	Traveling carriage	Have permanent emplacements on left flank.
		3 3-bar. Nordenfel't.	Parapet mounting.	

POWER OF GUNS.

Nature	Penetration of W.I. in inches					Weight of		Remarks.
	M'zle	500	1000	2000	3000	Charge	Projectile	
						lbs.	lbs.	
10″ B.L., Mark II.	22.3	21.4	20.4	18.6	16.9	252 P' Brown	500	Common shell will penetrate about ½ of these thicknesses.
12.5″R.M.L. " I.	17.4	16.7	16.0	14.7	13.5	165 P' Black	820	
6″ B.L. " IV.	12.4	11.4	10.5	8.9	7.5	48 E.X.E.	100	

Note I.—Against "Hard Armor," the guns will only penetrate $\frac{4}{5}$ of the above thicknesses.

Note II.—Perforation decreases as the shot strikes more or less obliquely and, against "Hard Armor," it has decreased 0.8

of the direct perforation before reaching 55° with the plate when it glances off; against W.I., the glancing angle is 45° when the perforation has decreased to 0.7 of its normal amount.

Preliminary Arrangements.[*]

I.—Receive reports that the groups are ready for action and that the group differences have been chalked on the gun drums, or crest-rings in the case of guns fitted with front pointers.[†]

II.—Ascertain that each G.G.C. is in possession of his "fighting card."[‡]

III.—Test all means of communication and see that all electric order dials (if used) are "at stops."

IV.—Settle whether tangent or quadrant elevation is to be used.

Note.—Quadrant elevation should always be used, if possible, in preference to tangent elevation, as, by so doing, "personal error" is eliminated and the service of the gun accelerated owing to the operations of elevating and training being carried out simultaneously.

Battery Commander's Corrections are:—

I.—For range—
  (*a*) Tide (not necessary in case I.)
  (*b*) Powder error, or error of the day.
  (*c*) Travel of objective.

II.—For deflection—
  (*a*) Wind.
  (*b*) Point of impact.
  (*c*) Travel of objective.

Rules for Battery Commanders.

I.—No battery commander may select his own objective, but must direct his fire on that indicated to him by the fire commander.

---

[*] These may have to be amplified to meet local conditions; those given are common to all forts.

[†] In the case of mountings fitted with front pointers the system of chalking the differences on the gun drums will be found most inconvenient, as the gun captain will have to run round to the front every time he wishes to ascertain what the difference for any particular training is. The following method has been used with success:—Mark, with chalk, sections on the crest-ring corresponding to those on the gun drum, and, in these sections, chalk up the differences. Now, if a temporary pointer be fixed to the shield (H.P. mounting) vertically above the permanent Pointer, the gun captain can read the differences without moving from his post in rear. Further, if the pointer be extended a few inches *above* the shield and the chalk marks also carried up to the upper crest-ring, the gun-layer can himself read the difference, even when laying the gun run up.

[‡] For specimen form, see end of book.

II.—No battery commander may open fire until permitted to do so, with the whole or part of his armament, by the fire commander, except under exceptional circumstances, when he may do so on his own responsibility, reporting his reasons for so doing to his fire commander.

III.—A ship signalled by the fire commander as N.C. (not classed) is to be attacked at all fighting ranges with C.P. down to the water-line.

A ship signalled as U.K. (unknown) is to be attacked at all fighting ranges by C.P. Fire to be directed at her superstructure generally.

SALVO POINTS.*

(Applicable only to forts commanding a narrow channel.)

I.—When a ship advances to within 1200 yards† of the first "salvo point" with the intention of "running past," the battery commander gives the signal: "Lay on salvo points"—viz., "Puts visual dials to zero" or "electric dials to stops." On this signal, the G.G.C.'s order their groups to be laid on "salvo points" as under‡:—

A Group on points, Nos .... & ....

B Group on points, Nos .... & ....

C Group on points, Nos .... & ....

II.—After the dials have gone to zero for "salvo points," no notice§ is to be taken of any subsequent range appearing on the dials until the ship has either passed the last point or is disabled, when the order to "concentrate"—*vide* III. below—will be given by the B.C.

III.—If a ship is disabled when passing "salvo points," the B.C. gives the signal "to concentrate" by raising a "blue flag" at his fighting station and blowing a whistle to attract attention. On this signal, all groups concentrate on the disabled ship at the *mean range* of the two "salvo points," between which she then is until the correct range appears on the B.C. dial.

IV.—After a ship has passed "salvo points," groups will continue firing independent group salvos until "cease fire" or "change of objective" is sounded.

---

* These are imaginary points in mid-channel over which the ship must pass and whose range and training have been previously determined and painted on the gun-drums.—"G.A.D." (1895), Vol. I., p. 486.

† A ship steaming 14 knots will traverse this distance in just over two minutes.

‡ The combination of salvo points must be arranged locally.

§ This is necessary to enable the B.C. to pick up the ship's range again as she passes the fort, so as to have same (with all necessary corrections) on the dials the moment the vessel has passed the last salvo point.

V.—The ammunition for "salvo points" should be conspicuously painted and kept specially handy for loading, as, if it has to be carried any distance, some of the points will, assuredly, be missed.

VI.—When the signal "lay on salvo points" is given, any gun which is just about to fire at a known range should deliver its fire before training on to "salvo points."

SIGNALS.

The following are used to indicate an objective and its probable method of attack :—

Heavy ironclad	indicated by	ONE
Medium "	"	TWO
Light " (including gun-boats)	"	THREE
Cruiser	"	FOUR
Torpedo boat and light craft	"	FIVE
Not classed	"	N.C.
Unknown	"	U.K.
Bombardment at long range	"	L.R.
" medium "	"	M.R.
Close action	"	C.R.
Running past	"	R.P.

*A range and bearing
or
Number of a square } indicates the objective.

The following message from fire commander to battery commander exemplifies the above :—

X—Four—150—R.P.—commence firing; meaning:

Fort X, engage cruiser in square 150; she will probably run past; open fire as soon as possible with all your guns.

This would be passed on by the battery commander to his gun group commander in the following form :—

A—Four—4000—220—R.P.—commence firing; meaning:

A group, engage cruiser, whose range and training from me (B.C.) 4000 yards and 220°; she will probably run past; open fire as soon as possible.

METHOD OF ATTACK BY SHIPS.

Ships can attack this Fort in .... ways† :—

I.—By bombardment at long range	Signal L.R.
II.—By attack at medium range	" M.R.
III.—By close attack	" C.R.
IV.—By running past	" R.P.

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* Is the best method of indicating a fast-moving objective to the *guns* when the depression range finder is close to the groups.

† According to local circumstances.

PRINCIPAL METHODS BY WHICH FORTS ATTACK SHIPS.

I.—By fire at the upper structures:—This has been termed "secondary attack," but, as it appears to be the best to adopt in the majority of cases and the most important one to consider, it may be better to term it the "shell attack."

II.—By fire at the belt and specially armored or so called "vital parts":—This has been termed the "primary attack" but it may be better to call it "attack of belt and primary parts" or, briefly "belt attack."*

NOTES FOR BATTERY COMMANDERS.

I.—The following trumpet and whistle sounds will be found useful:—

1 Blast on whistle	meaning	shot.
2 Sharp blasts on whistle followed by 1 long blast	"	miss fire, go on with next gun.
2 G's	"	change of objective.
3 G's†	"	salvo points.

II.—Each gun group commander should be provided with a small red banderole to be used as follows:—

(*a*) Red banderole to be stuck in the ground when the group is loaded.

(*b*) Red banderole to be lowered immediately the group has fired.

These flags should be placed so that they can be seen by the battery commander and are intended as an assistance to that officer in indicating what groups are loaded.

III.—In order to save as much time as possible, the following system for arriving at the "speed" and "deflection" correction is suggested:—

Battery commander .... Speed
Drum reader .... Now * * * stop 2500 (any range).

The interval of time elapsing between the words "now," "stop" represents the time taken by the objective to alter its range by 50 yards, which time is taken by the battery commander in seconds with a stop watch.

The correction for speed is then at once ascertained by reference to the tables.

"Deflection" is found in a similar way.

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* *Vide* "General directions for the attack of ironclad ships."

† In connection with visual signal to attract attentions and when former cannot be seen owing to smoke or any other reason.

IV.—To obviate the necessity of a battery commander writing his orders and making the calculations necessary for "speed," etc., corrections, it is suggested that he should have on his staff a quick, neat writer to do all this for him. His attention need not then be distracted from his own particular work—viz., observation of fire.

V.—The following sequence and form of orders from a battery commander to his gun group commander when fighting a fort is suggested:—

A
IV.
183
R.P.
Salvo, Right to Left (or Left to Right)
Case I.

meaning:—

A group engage cruiser whose arc bearing is about 183°; she will run past. Nature of fire group salvo from right to left. Tangent elevation.

After sending the above, the battery commander ascertained his corrections as follows:—

Battery commander to drum reader		"Speed."
Answer		"Now."
		"Stop."
		2400.
Battery commander to clerk	Powder	+ 50.
	Speed	—225.
	Tide	± 0.
	Impact	+ 60.
Clerk		—115.
B.C. to dial No.	Range correction	—125.

Note.—The battery commander gives his corrections to the dial number in the nearest multiple of 25 to enable him to put it on the dial which only reads to 25 yards.

B.C. to drum reader	Range at	50 (or 100).
Drum reader.....2300	On dial	2175.
"Range"	"	2125.
"	"	2075.

and so on.

When the range appears on the dials, the battery commander sounds "commence firing."

VI.—The best form of attack against a ship approaching or lying nearly head on is "common shell above the belt."

VII.—The conning tower of an ironclad is generally a little before the funnel. This position, being vital to the maneuvring of the ship, is usually heavily armored, but a shell bursting *under* it may destroy the communications and means of commanding the ship—to say nothing of the *personnel* of the staff. Failing this, the fire of even the lightest Q.F. guns may confine the staff inside the tower and greatly hamper the directing power of the ship.

VIII.—The tops of military masts form such difficult targets for direct attack that it is generally preferable to fire at the masts near the deck with C.P. from pieces of a suitable size. It is to be noted that the larger masts are used as ammunition hoists for the tops.

IX.—If, when a group is on any objective, "fresh objective" sounds, which fresh objective necessitates a change of projectile, the group should be, at once, trained on and fired at the old objective and then loaded with the projectile suitable for the attack of the new objective.

X.—The armor on turrets and barbettes does not, in many cases, extend down to the belt; consequently, there is a large vulnerable space open to the attack of common shell between the two.

PART II.

THE ACTION.

ATTACK NO. I.

AGAINST HEAVY IRONCLADS.—SIGNAL—ONE.

General Description.

These ships are heavily armored, their "vitals" being protected by steel or compound belt varying from* 17.2 to 21½ inches in thickness (equivalent to from 21.5 to 28 inches W.I.), and carrying their heavy guns in barbettes and turrets, armored with from 12 to 18 inches of compound armor (equivalent to from 15.5 to 22.5 inches W.I.). With the exception of the belts and barbettes, the whole of the hull of vessels of this class is open to "shell attack."

General Idea for Attack.

The unarmored portions and superstructure of these ships should be the principal object of attack.

When the ship's guns are mounted in barbettes, a common shell entering just below the barbette will probably meet with little or no resistance and may jamb the turn-table and so put the gun out of action.

The Q.F. and movable armament should be employed to keep down the fire from the tops.

Quick fire direct into the mouths of the heavy gun shields would probably be effective.

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* Fort X being armed with one group of 10″ B.L., the lower limit of armor constituting a "heavy" ironclad is arbitrarily fixed—*vide* Introduction to this paper.

DETAIL OF PROJECTILES.

Group	Range—in yards	Projectile	Object of fire
A	5000 to 1200	C.P.	Unarmored portions and superstructure.
	1200	C.P.	Stand by for the signal "Lay on S.P." At this signal, lay on points Nos........and........and fire as the bow (or counter) of the ship crosses the line of sight.
	After the ship has passed last S.P.	C.P.	Independent group salvos at the steering gear.
B	4000 to 1200	C.P.	At unarmored portions and superstructure.
	1200	C.P.	Stand by for the signal "Lay on S.P." At this signal, lay on points Nos........and........and fire as the bow (or counter) of the ship crosses the line of sight.
	After the ship has passed last S.P.	C.P.	Independent group salvos at the steering gear.
C	All ranges above 1200	C.P.	Unarmored portions and superstructure below conning tower.
	At 1200	C.P.	Stand by for the signal "Lay on S.P." At this signal, lay on points Nos........and........and fire as the bow (or counter) of the ship crosses the line of sight.
	After the ship has passed last S.P.	C.P.	Independent group salvos at the steering gear.
D	2000 to 1000	C.P.	Direct into the mouths of heavy gun shields.
	Below 1000	C.P.	Conning tower.
E	2000 to 1000	C.P.	At tops to keep down fire therefrom.
	Below 1000	C.P.	Conning tower.
Movable armament 40-pr. R.M.L.	Below 1000	C.P.	At base of masts carrying tops to destroy ammunition hoists thereto.

ATTACK NO. II.

AGAINST MEDIUM IRONCLADS.—SIGNAL—TWO.

GENERAL DESCRIPTION.

Ships of this class are generally fairly heavily armored, their belt armor being usually composed of steel or compound plates, varying from 14.8 to 17.2 inches in thickness (equivalent to from 18.5 to 21.5 inches W.I.) and carry their heavy guns in barbettes protected by compound armor, varying in thickness from 9.5 to 14 inches (equivalent to from 11.2 to 17.5 inches W.I.).

With the exception of the belt and barbettes, the remainder of the hull is open to "shell attack."

GENERAL IDEA FOR ATTACK.

The unarmored portions of these vessels should be the principal object of attack beyond 2000 yards.

At ranges below 2000 yards, the heavy B.L. guns may attack the armor.

The Q.F. and movable armament being utilized to keep down the fire of the heavy guns and tops.

DETAIL OF PROJECTILES.

Group	Range—in yards	Projectile	Object of fire
A	5000 to 2000	C.P.	Unarmored portions and superstructure.
	2000 to 1200	A.P.	At belt.
	At 1200	A.P.	Stand by for the signal "Lay on S.P." At this signal, lay on points Nos ....and ...... and fire as the bow (or counter) of the ship crosses the line of sight.
	After the ship has passed last S.P.	C.P.	Independent group salvos at the steering gear.
B	5000 to 2000	C.P.	At unarmored portions and superstructure.
	2000 to 1200	A.P.	At heavy gun barbettes.
	At 1200	A.P.	Stand by for the signal "Lay on S.P." At this signal, lay on points Nos.........and.........and fire as the bow (or counter) of the ship crosses the line of sight.
	After the ship has passed last S.P.	C.P.	Independent group salvos at the steering gear.
C	All ranges above 1200	C.P.	Unarmored portions and superstructure below conning tower.
	At 1200	C.P.	Stand by for the signal "Lay on S.P." At this signal, lay on points Nos....... and........and fire as the bow (or counter) of the ship crosses the line of sight.
	After the ship has passed last S.P.	C.P.	Independent group salvos at steering gear.
D	2000 to 1000	C.P.	Direct into the mouths of heavy gun shields.
	Below 1000	C.P.	Conning tower.
E	2000 to 1000	C.P.	At tops to keep down fire therefrom.
	Below 1000	C.P.	Conning tower.
Movable armament 40-pr. R.M.L.	Below 1000	C.P.	At base of masts carrying tops to destroy ammunition hoists thereto.

ATTACK NO. III.

AGAINST LIGHT IRONCLADS.*—SIGNAL—THREE.

General Description.

This class includes all ironclads carrying from 6.5 to 14.8 inches of compound armor (equivalent to from 8 to 18.5 inches W.I.) on their belts. Their guns are usually carried in barbettes armored with from 6 to 9 inches of W.I. The rest of the vessel is unarmored, or very lightly armored.

General Idea for Attack.

Above 2000 yards, the unarmored portions should be the principal object of attack; below this range, the heavy guns may attack the armor.

The Q.F. and movable armament being utilized to keep down the fire from the heavy guns and tops.

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* This class will include the larger cruisers, *e.g.* "The Rurik."

Detail of Projectiles.

Group	Range—in yards	Projectile	Object of fire
A	5000 to 2000	C.P.	At unarmored portions and superstructure.
	2000 to 1200	A.P.	At belt.
	At 1200	A.P.	Stand by for the signal "Lay on S.P." At this signal, lay on points Nos........and....... and fire when the bow (or counter) of the ship crosses the line of sight.
	After ship has passed last S.P. .	C.P.	Independent group salvos at the steering gear.
B	5000 to 2000	C.P.	At unarmored portions and superstructure.
	2000 to 1200	A.P.	At heavy gun barbettes.
	At 1200	A.P.	Stand by for the signal "Lay on S.P." At this signal, lay on points Nos........and........and fire when the bow (or counter) of the ship crosses the line of sight.
	After ship has passed last S.P.	C.P.	Independent group salvos at the steering gear.
C	All ranges above 1200	C.P.	At unarmored portions and superstructure below conning tower.
	At 1200	C.P.	Stand by for the signal "Lay on S.P." At this signal, lay on points Nos ...... and...... .and fire when the bow (or counter) of the ship crosses the line of sight.
	After ship has passed last S.P.	C.P.	Independent group salvos at the steering gear.
D	2000 to 1000	C.P.	Direct into the mouths of the heavy gun shields.
	Below 1000	C.P.	Conning tower.
E	2000 to 1000	C.P.	At tops to keep down fire therefrom.
	Below 1000	C.P.	Conning tower.
Movable armament 40-pr. R.M.L.	Below 1000	C.P.	At base of masts carrying tops to destroy ammunition hoists thereto.

ATTACK NO. IV.

AGAINST CRUISERS.—SIGNAL—FOUR.

GENERAL DESCRIPTION.

These vessels are divided into armored and protected cruisers, the former having side armor from 4 to 5 inches in thickness and having their guns protected with about 7 inches of armor.

The protected cruisers have their sides protected by coffer dams and coal bunkers.

Their guns are unprotected.

GENERAL IDEA FOR ATTACK.

As this class of ship will always try to run past forts at speed, every endeavor must be made to injure their hulls.

At all ranges, use C.P. at their "vitals" and superstructure, special attention being paid to the conning tower.

DETAIL OF PROJECTILES.

Group	Range—in yards	Projectile	Object of fire
A	5000 to 1200	C.P.	At the hull, down to the water-line.
	At 1200	C.P.	Stand by for the signal "Lay on S.P." At this signal, lay on points Nos........and........and fire as the bow (or counter) of the ship crosses the line of sight.
	After ship has passed last S.P.	C.P.	Independent group salvos at the steering gear.
B	5000 to 3000	C.P.	At the hull, down to the water-line.
	3000 to 1200	C.P.	Below the conning tower.
	At 1200	C.P.	Stand by for the signal "Lay on S.P." At this signal, lay on points Nos....... and........and fire as the bow (or counter) of the ship crosses the line of sight.
	After ship has passed last S.P.	C.P.	Independent group salvos at the steering gear.
C	5000 to 3000	C.P.	At superstructure.
	3000 to 1200	C.P.	At conning tower.
	At 1200	A.P.	Stand by for the signal "Lay on S.P." At this signal, lay on points Nos...... and...... and fire as the bow (or counter) of the ship crosses the line of sight.
	After ship has passed last S.P.	C.P.	Independent group salvos at the steering gear.
D	Below 3000	C.P.	At conning tower.
E	Below 3000	C.P.	At conning tower.
Movable armament 40-pr. R.M.L.	Below 2500	C.P.	Below the conning tower.

ATTACK NO. V.

AGAINST TORPEDO BOATS.—SIGNAL—FIVE.

General Description.

This class includes, besides torpedo boats proper, all small craft, such as launches, boats carrying landing parties, etc.

General Idea for Attack.

Q.F. guns are the weapons *par excellence* to repel this form of attack. Consequently, all guns of this nature should be utilized to the utmost extent.

With regard to the other natures of guns, *only those which, from their position, will not interfere with the Q.F. guns by obscuring the view with smoke, will be used.* The only projectiles from these guns which will be of any use against such a rapidly moving objective as a torpedo boat are those having a large cone of dispersion. Consequently, shrapnel shell and case shot should be exclusively used. The best burst for the former is 150 yards short.

DETAIL OF PROJECTILES.

Group	Range—in yards	Projectile	Remarks
A	*5000 to 1100	S.T.	Burst 150 yards short of objective.
	1100 to point blank	Case	
B	*5000 to 1100	S.T.	Burst 150 yards short.
	1100 to point blank	Case	
C	*4000 to 600	S.T.	Burst 150 yards short.
	600 to point blank	Case	
D	All ranges below 4000	C.P.	
E	All ranges below 4000	C.P.	
Movable armament 40-pr. R.M.L.	All ranges below 3000	S.T.	Burst 100 yards short.

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* By day only; at night, it is limited by the range of the electric light.

ATTACK NO. VI.

NIGHT ATTACK.

Before leaving the fort for the night, all the guns of the primary armament should be laid parallel across the channel, and loaded—*vide* "Detail of Projectiles."

Group **A** with elevation of .... 1°
" **B** " corresponding to 1100 yards for B_1
1400 yards for B_2
" **C** " " 1700 yards for C_1
2000 yards for C_2

DETAIL OF PROJECTILES

Group	Projectile	Remarks
A	Case shot	
B	S.T.	Fuzed for 1100 yards for B_1 1400 yards for B_2
C	S.T.	Fuzed for 1700 yards for C_1 2000 yards for C_2

Now, in the case of a torpedo attack during the night, the whole of the water area from 600 to 2000 yards can be swept at a moment's notice with case and shrapnel bullets. The area for 600 yards from the bank must be defended by the 40-pounders of the movable armament firing shrapnel or case assisted by the machine guns.

In addition, volleys of rifle fire from all the infantry allotted to the fort should be directed on any boats which may be visible.

Note.—In this form of attack, Q.F. guns act as described under Attack No. V.

In case of any other form of attack taking place during the night, the loaded guns should be immediately fired off and reloaded.

Group **A** with A.P.
" **B** " C.P.
" **C** " C.P.

and run on salvo points.

Group **A** on points Nos..............and...............in succession.
" **B** on points Nos...............and.............in succession.
" **C** on points Nos...............and ....in succession.

Note.—Any craft moving after dark is to be followed and ruthlessly sunk.

G.G.C.'s FIGHTING CARD—FRONT. (*Specimen Form.*)

A GROUP.

Class	Range—in yards	Projectile	Remarks
I	5000 to 1200	C.P.	Aim at unarmored portions.
	At 1200	C.P.	Prepare for salvo points. Nos . . . and. . . .
	After passing S.P.	C.P.	Independent group salvos at steering gear.
II	5000 to 2000	C.P.	Aim at unarmored portions and superstructure.
	2000 to 1200	A.P.	Aim at belt.
	At 1200	A.P.	Prepare for salvo points. Nos. . ..... and . . .
	After passing S.P.	C.P.	Independent group salvos at steering gear.
III	5000 to 2000	C.P.	Aim at unarmored portions and superstructure.
	2000 to 1200	A.P.	At belt.
	At 1200	A.P.	Prepare for salvo points. Nos...... .. and .....
	After passing S.P.	C.P.	Independent group salvos at steering gear.
IV	5000 to 1200	C.P.	Aim at hull down to the water-line.
	At 1200	C.P.	Prepare for salvo points. Nos........ and ..
	After passing S.P.	C.P.	Independent group salvos at steering gear.
V	5000 to 1100	S.T.	Burst 150 yards short.
	1100 to point blank	Case	

REVERSE.

B.C.'s Signals.

Heavy Ironclad	I	Bombardment, Long Range	L.R.
Medium Ironclad	II	Bombardment, Medium Range	M.R.
Light Ironclad	III	Close Action	C.R.
Cruisers	IV	Running Past	R.P.
Torpedo boat	V	A bearing .... indicates	Objective
Not Classed	N.C.	Visual dials at zero or } "	{ Prepare
Unknown	U.K.	electric dials at stops }	{ for S.P.

Sounds.

1 Blast on whistle	means—	Shot.
2 Short blasts on whistle followed by 1 long blast	"	Miss fire, go on with next gun.
2 G's	"	Change of objective.
3 G's	"	Salvo points.

G.G.C.'s Signals.

(i.) Red flag up when group is loaded.
(ii.) Red flag down when group has fired.

" DEFENSE FOR SECONDARY FORTS AGAINST PROBABLE ENEMIES, BASED UPON AN APPRECIATION OF PECULIARITIES OF THE PERSONNEL AND MATÉRIEL IN SUCH ENEMIES."

BY FRED. T. JANE, ESQ.

(A Lecture delivered at the Royal Artillery Institution, Thursday, February 20, 1902,)

My great object is to try and give you the ideas so far as I can gather them, which obtain in foreign Navies on the subject of attacking forts.

I think it is a generally accepted axiom that what the enemy proposes doing is a great deal more important thing than what we think he can do. If he thinks he can do a thing he will do it. As far as I can make out the enemy thinks he can do a great many things that our newspapers and reviews and other authorities say he cannot do. We have one general idea as regards naval warfare: that is, that we shall shadow the enemy; that directly war is imminent our ships will be shadowing theirs wherever they go; that we shall have two or three ships on to theirs and smash them right away; that the forts exist simply to satisfy old women who may be nervous, and that no Garrison gunner will ever have to fight, and no forts will ever be attacked. Ships in this British view will simply confine themselves to fighting each other, and as we have about three ships to one French, or four to one German, or five to one Russian, all we have to do is to smash the ships away merrily and then the war will be over. That, of course, is a very beautiful idea in theory, but we should take into account that every brilliant foreigner is thinking out how he can defeat that idea, and the one man who more than any other has devoted himself to this is the French Admiral Fournier. Admiral Fournier is probably the greatest Admiral who has ever lived so far as originality or anything of that sort is concerned, and he has laid himself out, from everything I can hear in France and from Frenchmen—to solve one question :—"I have a certain force at my command; the British have an infinitely superior force; what can I do to smash up that British force?"

In doing that of course he has thought out what are the weak points of the British fleet and the British nation. The weak point that he has set on appears to be that there is absolutely no co-operation between the British Navy and the British Army; that forts are scattered about over the coast, acting by themselves, and that the British fleet is also scattered about acting by itself. Arising out of that idea we may see in the French naval maneuvres that the great scheme has been not ships against ships, but to have bombardments of forts and landing parties for attacking forts in the rear—everything, in fact, that comes under the head of the *guerre de course*. We read in the *Times* and in all important English newspapers that the *guerre de course* is all humbug, but the French believe in the *guerre de course*, and if they are working for it, it appears to me that if our artillery do not study the *guerre de course*, to a certain extent, they are very likely to be taken just in the place where they do not expect it.

When the French consider the theory that ships cannot fight forts, they take perhaps, first of all, the Crimea. In the Crimea, we had wooden ships, and the Russians had stone forts, and at first the wooden ships were knocked all to pieces by the forts; but a little later, at the bombardment of Kinburn, we, or rather the French, had three floating batteries, armor-plated; the Russian forts were earthworks, and in three hours those forts were knocked all to pieces—the ironclads steamed in to within 800 yards, and simply knocked everything silly. Ships now-a-days are perhaps more relatively vulnerable than those floating batteries, but the French have never forgotten that particular fact, and you still hear of it over there. Coming on to later times, we may take the bombardment of Alexandria. Here again ships were matched against forts; the forts were low down on the water's edge and, although no great harm was done, the gunners were swept away and the forts were silenced so far as the fleet was concerned, and the fleet was able to do what it wanted. The fact that the guns in the forts were still able to fire and that little material damage was done, did not affect the main issue, which was that Alexandria no longer existed as an Egyptian defense. Coming on to still later times, we may take the Chinese War. We find that at Wei-Hai-Wei the Japanese took the forts chiefly by landing troops, but they also bombarded the forts to begin with. In the bombardment, they did very little damage, but their ships being cruisers very little can be gathered from that. The only point I wish to particularly draw attention to in that war is that, according to the Japanese accounts, there were two 4.7's on disappearing mountings, which sounds rather a contradiction in terms; but every Japanese insist that that is what they were. Those two guns were mounted high up somewhere near Wei-Hai-Wei ; two cruisers went out and fired at them for an hour or two without any harm at all, and then, being hit by the forts they gave it up as a bad job. As regards the other forts, the low lying ones, they were attacked, and the Chinese ships with them. The *Ting-Yuen*, which had been torpedoed, was badly knocked about, according to a lot of photographs that I have seen that were taken immediately after the bombardment, and another ship that had also been torpedoed, the *Ching-Yuen*, was sunk, but the harm done to the other Chinese ships appears to have been trifling and in some of them I have not seen a single mark of a hit, from which it appears that a fort platform by itself would not necessarily have a very great advantage over a ship that is close by. Now during these operations it should be stated that the Chinese before evacuating the forts destroyed most of the breech pieces of the guns. This does not tally with newspaper reports, but my authorities are Japanese Naval and Military officers who were there. The working guns, so these tell me, were two (or three) oldish 8-inch Krupp, one (or two) fairly modern 6-inch and several old M. L. guns that the gave up trying to use (an item that may be of interest to those of you who belong to forts with old M. L. as the chief piece). Roughly the Japanese had one captured gun to one Chinese ship—say one gun against three or four. Later they had fewer. They manned a battery at the eastern entrance—an earthwork in three tiers. From here they made good shooting. The battleship *Chen Yuen* then steamed up to a thousand yards and let drive one broadside, four 12-inch, two 6-inch and some Gruson 4-pounders. That one broadside absolutely annihilated the earthworks.

From the Chino-Japanese war, we may pass to the war between Spain and America. We know the war between Spain and America chiefly from the account of the mule that was killed in the bombardment of Matanzas. So far as can be gathered from the conflicting accounts that are given—and I have spoken to both American and Spanish officers who were there about it—the Spanish guns which the Americans really had trouble with at Matanzas and elsewhere, were generally some field-pieces mounted in a wood and firing smokeless powder, so that there was no indication where the guns were. The ships never hit those guns; never got near them, and never knew where the were ; but as these plantation guns did no harm to the ships, that does not stand for much one way or the other when we are trying to form an opinion as to the value of a fort against a ship.

At Santiago the guns were high up and there we know that nothing effectual was done by the American fleet. The American gunnery does not seem to have been particularly good.

If you take a modern ship of the *Wittelsbach* class, with say four 9.4's, nine 6-inch guns, six 3.4's (that is, 20-prs.), and about a dozen little guns on the broadside, and compare that ship with an ordinary sealed pattern battery, mounting two 9.2's, and two 6-inch guns, you will find that the ratio of fire from the ship to the fort is about ten to one. Assuming it to be a low level fort —although the ship will be hit by the fort oftener than she will hit the fort, for every hit she gets, or which she expects to get, she will do relatively more damage, and it is in that belief that the foreigners seems to be working the thing out.

I might perhaps here mention a scale we have in the Naval War Game, worked out by a mean. There has been a great deal of discussion about it, because there is a very great variety of opinion, but the scale we have worked out by taking the mean of everybody's opinion is that if forts are at the level of the water, one gun in a fort may be reckoned as one gun in a ship; if the fort is 50 feet up, then one gun in the fort is worth two in the ship; if it is 100 feet up, one gun in the fort is worth four in the ship; if it is 200 feet up, one gun in the fort is worth eight to ten in the ship, and so on, till you get up to a rise like the guns at Gibraltar, where one gun in the fort is worth several hundred in the ship. This is given a certain amount of variety in the War Game, because there a ship is not given the same chances against the fort as the fort is against the ship, but this is the scale that has been taken; it has been worked out chiefly by foreign officers.

If we take the last French Naval Maneuvres we find that the one great thing that was carried out was a scheme of attacks on forts right through. *Here* they would be landing against some small battery; or there would be a large attack on a place like Ajaccio, but always there were fort attacks. All the target practice was on the same principle. All the French cruisers in the last maneuvres were sent out to target practice designed to represent a long range bombardment. I have not been able to discover what sort of shooting they made, but I have found out that this sort of target practice is quite common in the French Navy, which would imply that even a first class fortress is not altogether outside their ambitions. A great many of them seem to have the idea that in the event of war, we shall endeavor to shadow and blockade them, but that with their submarine boats, we shall be unable to blackade them closely. They are building submarine boats, not with a view of revolutionising war but to render blockades impossible, and they are all firmly convinced that with these submarines which they concentrate now at Cherbourg and places like that, we shall be unable to blockade them and unable to stop ships from slipping out and getting off Portsmouth or some place like that by night; and having practised at this long range bombardment, they believe that they will be able to lay their guns with a fair amount of certainty so as to drop shell somewhere in the town, and that although they may not hurt the dockyard and probably will not do any great damage damage anywhere, the moral effect of that will be worth something to them on account of its effect on the people in the forts. They argue that if the people in the forts find that they are powerless te stop this, they will lose confidence in themselves, and in the event of an attack elsewhere the people who have heard about that will be anticipating that sort of attack and will lose confidence. That I think is about all I need say with reference to first-class fortresses. The generally accepted axiom is that no fleet is going to steam in and attack a place like Portsmouth, any more than we should attack Toulon, except in the final stages of the war. There is a foreign theory that to send ships to attack our bases and *get sunk in the fairway* would be sound ; but no one here seems prepared to consider it seriously.

With secondary fortresses I think we must admit that it is quite different. Circumstances may arise (whatever views are held) in which an outlying coaling station may need be captured, and it will be for the fleet to capture it. With the French fleet it is certain to be so, because the whole of their ideas are based on that. They know perfectly well that we all of us believe that a ship has not got a ghost of a chance against a fort. There the forts are, and our people say the fort will never fight and the Garrison gunner is "simply an ornament to prevent old women from being frightened—that is all he is required for and nobody in the forts will ever do anything." The Garrison gunner believes it himself, or he is gradually getting to believe it. He has been told so often that he will never have to fight that he does not think he will, and there lies the opportunity of the French ; indeed the opportunity of any Power that attacks us lies in that. If we do not expect attack in that quarter we shall probable have made no preparations and they will catch us there—that is the opinion publicly promulgated.

I have found a great many foreign officers who are of opinion that there will not be any fleet actions in the next Naval War, and that the whole war will be nothing but a sort of guerilla war like that which is going on in South Africa. Seeing that they can do nothing with ships against ships, they are going to do what they can on the tactics of De Wet, and there will be a series of naval De Wets. I have never yet met one who said he believed that such tactics would lead to ultimate victory; they do not expect ultimate victory out of it, any more than De Wet expects it; but they do expect this, that if they can manage by their submarines to prevent us blockading, they will be able to get ships slipping out, they will be able to hit us here and there, and evade us now and then, and will do a sufficient amount of damage and cause a certain stoppage of trade, the moral effect of which will be to make us unable to carry the war on any longer. It is not a very brilliant hope, because if we carry the war on it is bound to fail in the end; but it is a much better thing from their point of view than any battle of fleets, in which they are bound to be defeated.

Take a second-class fortress, which we will say has a sealed pattern battery of a couple of 9.2's, two 6-inches, and perhaps some small guns defending a mine field; if that is going to be attacked at all by the enemy, they will do so in overwhelming numbers, and in that case there are four points to remember. One is that the enemy will be fully acquainted with every gun in the fort and where that gun is. The second thing to remember is that after they have crushed the fire of it as well as they can, they will land and capture it and destroy the guns or occupy the fort according to circumstances. The third thing is that foreigners are perfectly convinced that if they get within two thousand yards of any earthwork, there will be none of that earthwork left. I do not say whether that is true or not, that has nothing to do with the subject I am attending to. The foreign idea is that once you get a ship within two thousand yards of a fort there will be no more fort; that is the point. The fourth thing is that they have only a limited time at their disposal because I cannot conceive of a state of affairs in which, although the enemy's fleet may have evaded our fleet, there will not be a British fleet coming along from somewhere and stirring them up. Therefore whatever they want to do, they have got to get done quickly. The chances of the fort depend on what it can do in the meantime.

It seems to me that there are three things that the fort is concerned with, and the first and most important perhaps of these is the *personnel* of the attack. We never hear much about the *per-*

sonnel in connection with ships; we hear plenty of it about armies, but very little of it about ships, yet the *personnel* is probably a larger feature in ships than it is even in land armies. The second thing is the *matériel*, of which we hear plenty, and the third thing is the tactics of the enemy.

The sailors of the French Navy are very much like French soldiers. They rush on to victory very easily, but if they get checked they will retreat very easily. All the officers of the French Navy that I have come across, I have found to be great men for applied tactics. There is an impression in England that a Frenchman is simply chock-full of theory and has no idea of putting his theory into practice or of anything else. I cannot say that I have ever seen anything in France to bear out that impression. French Naval officers seem to me to be the most practical of men in having a reason for everything they do, and I think even their tactics and everything in connection with their tactics, seems to be worked out on an appreciation of their *personnel* and on the fact that their *personnel* can be shaken. The object of a fort attack by the French would, it appears to me, be best understood by bearing in mind the peculiarity of the French *personnel*. The peculiarity of the French *personnel*, which occurs even in target practice, is this; If you get British gunners or sailors or anybody else at target practice and two or three men miss, the next man who comes along is all the more anxious to hit in consequence; but if you get Frenchmen at target practice and three of them miss, the next man will shoot badly; from the mere fact that three before him have missed, he gets the idea that it is an impossible thing, and he loses heart with it.

Out of this I think a fort firing at the French which has let off a number of guns very quickly but not hit them materially, would probably do more *moral* damage to the French than if it fired slowly and hit them. As regards the French tactics, these are all very carefully thought out. Their favorite tactical idea at the present moment is steaming around in a circle, continually altering the range. Of course, all that is done mathematically; they have it all laid down, the range will be decreased at such and such a time so much, and will be increased at such and such a time so much. They have no range-finders at present, and they trust to range-finding guns, these, of course, being mounted in the upper works. Their position cannot be known, but if you fire on the upper works you should upset these guns and so that might be of some value. As regards firing at French ships, as everybody knows, the peculiarity constructionally of a

French ship is a complete water-line belt that no gun in any of our forts could possibly get through with anything. Above this there is apt to be a gap, except in the later ships, where they have a thin belt, which in the ordinary way might be penetrated by the 6-inch Mark VII.; but as the French build their ships and work all their tactics on an idea of fighting at an angle of 45 degrees so as to increase resistance, it would not be much use firing at that belt, even if there is any chance of hitting it, and as the target it offers is very small, there is really no prospect of hitting it save by mere chance. It is generally believed that the French big guns are simply in barbettes somewhere up in the air, and that there is a place underneath where, if you put a shell, there would be an end of the gun; but all the French ships I have seen have had a very thick armored tube under the guns, which acts as a perfect support and against which shell fire would be useless—at least that is what they say. Their opinion is that a shell would do no more harm at the base of a French big gun than at the base of a British big gun.

But there is always one weak spot in French ships which French naval officers talk about, and which is generally discussed in France. That is the stability of the ships. They always have a large amount of top hamper, and they are, as I have said, constructed with this thick belt and then above that something without armor. All Frenchmen are of opinion that their ships may be pierced along the water-line, seeing that the belt is probably more or less under water, even if she floats at her proper water-line, as few French ships do ; at any rate, the belt cannot be more than a couple of feet above the water. When steaming at any speed, that makes a big bow wave and may let water into the lower deck, and if they get water into the lower deck, and cannot get it out, those ships will either capsize or be entirely unmanageable. That is the reason why they have put this thin upper belt on their later ships. Therefore as regards the later ships it is not much good hoping to hit the waterline ; the fire would have to be kept on the upper works and you would have to trust to the moral effect that it had there. But in the case of an old French ship, which I believe is the most dangerous one to fight, because the older the French ship, the more guns she carries as a rule—then if she is hit once by a large shell on the water-line just above the water, or even if a battery of 12-pounders could only hit her there she would no longer be a danger to the fort.

Let us now take the Germans. The Germans are absolutely different from the French. They are very stolid people, and the

German sailor, so far as I can understand him, seems very much like the German soldier. His idea of fighting a fort would rather be that he would steam in. He would make up his mind beforehand exactly at what range he wanted to attack the fort. He would drop his anchor at that, and then he would let drive at the fort. You will see that he has in that way as good a platform as the fort has. He would have no vibration from the engines, and the probability is that there would not be much sea on, and he would have an absolutely steady target. Under those conditions he thinks he would be able to pick the guns off deliberately one by one. His *morale* will not be shaken by a few shells bursting around him or anywhere else. There exist, I think, in cerplaces, high angle fire guns which are designed to move a ship that anchors and tries to knock a fort out like that. I know that in Germany for several years now they have been having a great many experiments with high angle fire on the decks of ships, and whatever they have discovered seems to have been kept very confidential, but has been embodied in their construction. I think that a German ship is probably as prepared as a ship can be against high angle fire. The best thing to move them probably would be a submarine. Of course if they knew there was a submarine about they would not stay still.

In regard to the construction of German ships, there is always a thick belt (the same as the French have) in the older ships of the *Brandenburg* class, which have heavy barbettes with very thin shields to them—about a couple of inch shields ; there is no protection to any of the guns worth mentioning, and wherever a shell hits in those ships it will knock them about. In the *Kaiser* class which followed, there is a tremendous number of guns, very few of which can be fired without interfering with some other gun. These ships are of very doubtful stability, and probably would not stand shell fire at all. But in the later ships of the *Wittlesbach* class, they have brought out what appear to be some of the best ships in the world. They have as much armor as the very latest *King Edward* class we have, and more guns, though they have not got the heavy guns we have. They have 9.4's instead. The whole of the ship is simply a mass of armor, and it is not conceivable that any fort fighting against that ship with 6″ guns would do any appreciable amount of harm. They might fire at it, but unless it happened to hit a gun muzzle or something of that sort, no hit would really affect that ship. The danger to that ship would be in getting the conning towers hit or the masts knocked over the side, and things of that sort, which would affect her steering. Whatever ship a fort is firing against there is always one thing the fort has in its favor. which is that there are sure to be channels and there are sure to be shoals, and if they can only get the enemy unable to steer, the enemy will go aground, and then if they can only get the enemy aground they have done infinitely more good than sinking him. It is better to drive one enemy aground than to sink two, because as long as any Admiral has a ship aground he will stay there and try to get it off, and then the British fleet coming up astern will probably get him.

As regards the Russians, the Russian *personnel* is easily panicked, but as, if a Russian gets panicked, they might flog him to death, and he knows it, he will prefer to stay, frightened or not, and so comparatively small moral effect is likely to be had upon him. It is not very likely that Russian ships would attack any forts we have, because they probably could not come over; but supposing they were to come over, the grave danger from Russian ships is that they carry a great many officers. Instead of the guns being laid and fired by blue-jackets and so on, a commissioned officer is doing that job, and although many of their officers are not very good, they all seem to have rather a knack in gunnery and a great proportion of them are very excellent shots. I think there would be a distinct difference between being fired at by guns aimed by officers and guns aimed in the ordinary way. In construction the Russian ships are not very good. They put plenty of armor on in the plans always, but in actual practice a certain amount of wood gets put on instead of the armor, or the armor is thinned down and is not so thick as it is supposed to be, and it is also very badly put on. It is made usually in France or America; it is imported into Russia, and it is there put on by rather indifferent workmen, and they get it on with large cracks. They do not seem to have the art of putting on the armor plates properly; their mechanical ability is not equal to it. Therefore probably in the case of any Russian ship, whatever her armor might be or whatever its thickness, if she was simply hammered the plates would begin to part and crack and let in water; even in target practice they have had that happen to one or two ships from the shock of firing.

As regards Japanese ships; we are not likely to be engaged against any Japanese ships. The Japanese Navy may be described best of all as Frenchmen in British or German ships. The Italians come under the head of French and may be treated as such, but they have very few efficient ships. The American

Navy is probably rather an over-estimated navy. They have a splendid *morale*; they have an idea that nobody can beat them, and that would stand them in very good stead and make it very difficult to shake them, but otherwise they are as yet numerically unimportant. All their later ships are covered with armor like the German *Wittelsbach*.

Summarising the attack to which this imaginary fort would be exposed, we find first of all that it will have an overwhelming fire upon it, and in the second place every naval man seems to be of opinion that they will give a fort shrapnel and high explosive alternately. If you burst shrapnel into a fort, you may not do much harm, but there is always the chance that the gunners may get down out of the way whilst it is on, which gives you a chance to get your landing parties in. If you give them high explosives you will probably cause such a cloud of dust that they will never see the ships. Many people abroad seem to have built some very fine theories indeed on the fact that with modern high explosives, if you can only once get the range of the fort and fire on the glacis and burst high explosives there, the fort will do nothing more, because it will see nothing more. It will be like the first *Belleisle* experiment; when there was simply a cloud of white all round the ship. That seems to be a thing very much thought about abroad. Of course you may say the fort may do the same thing to the ship, but the ship can move out of it and the fort is there a fixture. Distant position-finders may be a delusion; the enemy will probably know exactly where they are, and dose them accordingly.

Then of course there are ideas of drifting ships down. To let an old merchant ship full of smoky combustibles drift down to windward of a fort was a very old idea that got about at the time of the Crimean War, though it never came to anything then. I believe in some navies there are ships already noted down for that purpose, to be filled with oil and simply allowed to drift down in front of a fort so that its clouds of smoke shall keep the gunners from firing too much on the ships till the ships get within a nice range and can knock them out.

I have mentioned these matters in order to try and make you understand that as far as I can gauge the foreign mind, the foreign mind is filled with the idea that our forts can be destroyed, and that they can knock them out, and that they mean to have a try.

If we take the auxiliary means of defense we find mine fields, which do not seem to frighten the naval man very much. He has always got a firm idea that mines will go off too soon or too late. No sailor, if he wanted to get into a place, would be very frightened of the mines. Perhaps the same thing applies to Brennan torpedoes; they are to some extent visible, and so their position is known. The naval mind is so very fruitful of expedients in knocking out things of that sort, that if a fort is trusting to its mines and its Brennans, it will probably find itself on the wrong side.

There is one peculiar thing that I have heard in connection with search lights. At Portsmouth and Devonport we are very often having search light experiments, with a nice row of fixed lights and searching beams as well. I have come across foreigners who have advocated the opinion that if you get about four miles away from the search light, unless there are scouting ships about, you can remain there without being perceived. The search light offers no particular glare, and an enemy can preface a torpedo attack very well—supposing he has got into the range that he thought he was in—by laying his guns by the chart on the lights. By laying every gun on them, and firing shrapnel, he would possibly knock the lot of search lights out. I do not think any foreign fleet, unless it were a German one, would have a ghost of a chance of reaching an exact place if it wanted to; but the point is rather interesting as showing what the idea is.

All this indicates that when the next naval war comes along, the Garrison gunner, instead of having to sit down and do nothing, is very likely to have quite a warm and uncomfortable time of it. It seems to me that he cannot know too much about ships and that he should seize every opportunity of calling on board ships to talk with the officers—not simply to be shown round the ship and then have a drink and go away again. The naval man is always glad to talk shop; let the Garrison gunner talk shop with him, and so get an idea of the communications and understand the ship as a target, and realise the effect of shells bursting between the decks, and between the communications from the conning tower to the guns, or from gun to gun, and all that kind of thing. Of course if he can do so in foreign ships also, so much the better; but in the case of foreign ships, and I think especially French ships, they have rather an objection to showing anybody over. However, since all ships are very much alike in many of the general internal arrangements, I think that any Garrison gunner who had got into the habit of going on board our ships and moving about in the ships and realising where things were, and what they were for, would have a much better chance than a man who had never been on board one, and to whom it simply represented a target; he would have a much more accurate conception of what he could do to that target.

I am afraid that there is not very much knowledge of ships among our Garrison Artillery. I am not thinking of the cases that happened in the last naval manœuvres, where a number of Garrison gunners sank ships on their own side, because all the ships were British ships, and I do not suppose many Naval men could have told one from the other under the circumstances, as there were sister ships very often on both sides. In the second place, I believe the ships that were sunk were nearly always ships that had been put out of action and were coming into harbor—consequently, they did not trouble a bit whether the forts did see them or did not; they were 'out of action' and it did not matter to them, and they were not going to put themselves out about it. But I have heard another thing in connection with that matter. That is a very pretty little *ruse* that was mooted some time ago, which I believe is true. It was based on this idea—that this particular enemy were convinced that the people in our forts did not know a British ship from a foreign one. I do not say that they did not, but that was one idea which the enemy had. Their second idea was that there was absolutely no co-operation between the British Navy and the British Army, and they argued that, in the early stages of the war, if an unexpected foreign fleet suddenly appeared off any British fortress and flew the British flag and made a lot of signals, nobody in those forts would be certain what those ships were, or have any idea what the signals were; they would be able to get in sufficiently near, then they would suddenly open fire and knock the fort out. I do not say right away that that would succeed in the *ruse*, but it was certainly a thing that was going to be tried, and, what is more, will be tried when the next war comes.

In conclusion, I think we cannot realise too strongly the way the foreigners look at it. Although we build up very pretty plans and we write interesting articles and everything else to show that the only success in naval war is to be had in a battle of ships against ships, the foreigner realises quite fully that it is no good his trying ships against ships. He cannot do it, because he has got no ships to do it with, and he would have no chance whatever. He *must* therefore think out something else. He has thought out the *guerre de course*, which we read of as no good. We read that the French tried it in Nelson's day and the French did not win. But in all this that we read about the *guerre de* *course*, what we mean by the *guerre de course* is not what the French mean by it. Their idea of the *guerre de course* is not merely snapping up one or two merchant ships and that sort of thing; it is rather to snap up as many isolated bases and small coaling stations as possible and to worry us in every possible way. In the last French Manœuvers, a torpedo flotilla actually went and cut the railway line at some place, instead of going out and attacking the ships. The ships were in superior force, and the torpedo flotilla could not do anything in that direction, so they simply mooned about, landed in some place, notified the destruction of the railway line, and then went off somewhere else to a little coastguard station and destroyed that, then elsewhere and destroyed some more railway. Of course, that had absolutely no effect on the main operations, and everybody who commented on it said it was all nonsense and rubbish. But suppose they carry that thing out on a much larger scale, then they will have a chance of worrying us very much, and that is what they intend to do. It is no good forgetting that this is the thing we have to face. They are going for our forts; whether we think they will, or whether we think they will not succeed, does not matter. They think they can succeed. Admiral Fournier considered that problem, and we may say that all foreign ideas are colored by Admiral Fournier; the Russians simply copy more or less from the French plainly, and the Germans criticise the French things and then adopt them. Admiral Fournier has invented a variety of naval tactics which are now copied by the British Navy more or less. In the combined Mediterranean and Channel Fleet "Lagos Manœuvers" of the other day we were practising French tactics. In the autumn manœuvers the Channel Fleet were practising a variety of French tactics. Although you cannot say his ideas are adopted, that shows what an immense impression has been made by this French Admiral. He is a man who, so far as I can gather, does not believe a bit in that naval theory that "Strategy alters never and tactics do"; in fact, I have come across Frenchmen who say Fournier's theory is quite the opposite, that "the main principles of tactics never alter but strategy alters completely," and that with steam and modern guns and modern explosives, the wars of Nelson's time are absolutely no criterion for a war of to-day. Although we are inclined to copy his tactics in our fleets, we do not trouble a bit about his ideas. Everything that he has done seems to be worked on the one principle of waiting and waiting until there is a chance of going for a fort. I think it may be summed up best by a comparison with Chess.

Our ideas of naval warfare are like an orthodox game of chess played by ordinary players, where they take a piece and then another piece and so go on taking pieces and finally work up the game, and then one of them says, "Check !" "Check !" "Check!" —"Checkmate !" Fournier's idea is rather to have that checking on every possible occasion, with or without reason, and to get something for that "check"; while we are moving out of check, he will take something and what he means to take while we are moving out of check are our forts. If he cannot take them by direct attack, he will try to do so by land attack. I believe that very few of our forts are protected at all inland. They are generally put up with their fronts to the sea and they trust to providence and the chance that there will be some soldiers about to protect their rears. In the case of such a fort, if he can attack it that way by landing troops in overwhelming landing force, no foreign enemy will put his ships up in front of it ; but if he cannot do that, he will not be a bit afraid of standing up in front of the forts, and when standing up in front of a fort he will have the firm conviction that he can blow that fort out.

I have carefully abstained, as far as possible, from giving any opinions of my own that I may hold, because I do not see that mine matter ; but I do think that the French, German, and Russian—particularly the French opinions—on these matters require much more study than they get, and that in giving out the idea that everybody does give out in this country, that "the Garrison gunner is simply an ornament and simply exists to satisfy the people who may be nervous, and that he is never going to have to fight and that he is never going to have to do anything," we are laying up a very unpleasant time for ourselves in the next naval war. If only the French can pull off their theories, instead of the Garrison gunner sitting still doing nothing and the ships doing all the fighting, it is the ships that may perhaps have very little to do except in undoing their own and imitating the foreign tactics and attacking forts, and that instead of ship against ship blowing each other to pieces right away, the whole of the war may be a matter of ships against forts. Certainly the game of the French is to attack the forts. If we are ready for it, well and good. If our theories are right and the French are wrong, well and good. I must leave it to others to say whether we are right or whether we are wrong. I simply want to put these ideas before you.

THOUGHTS ON COAST DEFENSE SUGGESTED BY THE BOER WAR.*

By Captain H. E. PENNETHORNE, R. A.

[It is hoped that the publication of this paper will lead to the further discussion of at least three important points in Coast Defense, viz.:—1. The possible use of scouting boats. 2. The impossibility of a low site fort resisting modern naval attack seriously made, and the possibility of overcoming the difficulty by withdrawing from the coast line when high sites are not available. 3. The desirability of greater attention being given to the question of moveable armament and the defence of land fronts.]

The following stand out pre-eminent as lessons of the Boer War:—

(1).—The value of accurate information of the hostile movements.

(2).—The necessity of cover from fire.

(3).—The power of concealing guns given by smokeless powder and the immense value of doing so particularly to the defense.

(4).—The possibility of moving guns 6-in. and under of long range so as to act with a field force, and their great value in action.

(5).—Importance of mobility to all arms.

(6).—Value of two lines of defense the second commanding the first.

I.

SERVICE OF SECURITY.

The service of security in the Army consists, besides stationary outposts, of—by day—a widespread fan of mounted men and —by night—of reconnoitering patrols. These latter are always considered highly important and history shows that the want of them has often caused surprise and disaster. Our harbor defense system appears, nevertheless, to be that of stationary outposts alone, and that in spite of the fact that our enemy, the torpedo-boat, is twice as speedy as a charge of cavalry.

The time our present system gives us is, supposing the enemy to be seen in the sentry beams, about 2¼ minutes: if not, and this is not improbable, about 50 seconds.

In this time men who are asleep have got to wake up, man their guns, and open a rapid and destructive fire on very speedy targets in number probably not less than 3 or 4, possibly 16.

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The reason why this system is tolerated is that the idea of patrol boats is in bad favor. It is considered that:—

(1).—They will rush back through the defenses in company with hostile craft.

(2).—They will be destroyed, and therefore their crews are being sent to their death.

Our coast fortresses are however limited in number, the question is a local one, and examination appears to show that such a course is, in the majority of cases, unnecessary, for there are neighboring creeks and shallows to run into, and to work from altogether.

Local conditions will decide the exact arrangement of such vessels, there is however no question that provided all approaches can be seen they should lie still.

At sea, nothing but darkness prevents a full view, and all who have watched for boats at sea know that it is movement that betrays, either by the mere fact of motion or by flare or wash.

Most coast fortresses will be attacked but once, what is the possible loss of a few boats compared with the disastrous moral effect which would be caused by a successful surprise by the enemy, putting aside the actual loss in *matériel.*

Will not this boat system also save from annoyance by a few hostile boats, who, it may be, have no intention of actually attacking. Such boats approaching in the dark might well be put out of action by a few well directed shots from friendly boats lying quiet.

The necessity of using boats by day or on light nights will depend on the view obtainable from shore; if they work as they should from creeks and shallows outside the defended port, they can be ordered out at short notice by telephone and back to their bases by lamp or flag without the liability of letting in an enemy by mistake.

The difficulty of mutual recognition is inseparable from all scouting operations by night. The boats will be probably local in which case they will be well known.

Should an enemy slip through these boats, the defense is just as well off as if they had not been there, as all the present arrangements will be at work.

Summary :—(1).—Present system of security inadequate.

(2).—Boats to be used as an additional and outermost line of observation.

(3).—These boats to lie as a rule, stationary, and quiet, avoiding anything that might betray their presence.

(4).—To work entirely from neighboring creeks and shallows.

(5).—To retreat if seriously outnumbered to their own bases, otherwise to fight.

II.

NAVAL ATTACK.

Major Callwell in his "Tactics of to-day" makes it plain that the power of concealing guns given by smokeless powder is an immense gain to the defense.

It is now possible to conceal the position of our guns, not merely before they open fire, but in many cases altogether, especially with coast defense guns, our enemy being always below us and restricted to the sea as regards his movements.

With the heavy and elaborately mounted guns we can only conceal by such artifices as painting them an inconspicuous color, planting screens, and making the outline of works like natural ground. With 6-in. Q. F. and under, we now know there is no need to tie them to one spot, and these latter should have, besides their regular coast mounting, a travelling carriage carefully developed from those used in the present war.

The mobility of these guns, the possibility of concealing them with, on the other hand, the accuracy and rapidity of fire obtainable from a gun on a regular coast mounting with auto-sights will make the disposal of these guns for harbor defense a difficult problem which can be rightly solved only by careful local investigation.

On high sites, auto-sights (and consequently regular coast mountings) will be used because (1) they are then accurate ; (2) concealment is much less necessary because ships can only fire on high sites from a considerable range when their fire is far less accurate.

The vast superiority in weight of metal, and still more in number of projectiles, possessed by the broadside of a modern battleship over that of a modern battery ashore, seems to point to concealment being of more importance for medium sites than rapidity of fire, but we must not lose sight of the fact that our local conditions may call for great rapidity of fire rather than concealment; this would be the case if the works were built to prevent an enemy running past, rather than to deny the use of a harbor to him. In certain places it might be best to have alternative emplacements for the two tasks, some to resist running past, others to resist bombardment, and the 6-in. and under could be distributed as required, by the use of their field carriages, being removed from their mountings rapidly, by the use of some such arrangement as that used in the Royal Navy to run the guns on board.

Concealment seems nowadays the only hope for low sites. It will be difficult of attainment in the case of guns mounted for defense against raid by torpedo craft. These guns will need to be covered from fire by the solid parapets of the permanent works, or by specially constructed traverses.

The permanent works where they exist, must be protected from capture by landing parties, by means of concealed supporting guns which cannot be silenced and some of which should command the interior of these works.

As regards the guns for defense against raid they are when possible placed in a withdrawn position where they are safe.

(1).—*Raids.* Torpedo-boat raids are little affected by recent developments.

(2).—*Running past.* The enemy are more visible. The guns ashore less so.

(3).—*Bombardment.* In the days of Nelson, ships often silenced forts on *low sites.* For a time this power disappeared owing to the few guns carried by ships and the slowness of their fire. Alexandria appears to be an instance to the contrary, but it is generally admitted that good gunners would not have been driven from their guns by the damage inflicted.

This power re-appeared a few years ago owing to ships having Q. F. guns, and the forts practically none, and though somewhat diminished it still exists *i. e.*, it would take a modern ship rather longer to silence a modern fort than in 1895, but should not take over ½ hour.

If this be admitted, the necessity of a concealed and supporting armament is at once apparent in such places as have low site works, and that means almost all.

The attack might run something as follows:—

8 a.m. Enemy signalled. 8 miles.
8.15. Enemy (4 battle-ships) 6,000 yards. The defending B.L. and 6-in., 4.7-in. and 12-pdr, Q.F. open fire.
8.23. Enemy 3,000 yards, somewhat mauled.
8.27. Enemy anchors, 1,000 to 1,500 from known works and pours in terrific fire.
8.40. Parapets and neighborhood of works tremendously knocked about. Works have been silent since ships anchored.

Heavy and continuous fire has been hulling ships from guns mostly quite concealed and all dispersed.

8.40. to 9.40. Torpedo attack by boats, which had kept sheltered by ships. These on getttng nearly in are heavily fired on. (N.B.—Nothing mounted on the permanent works could have fired at all). Attackers sink some exposed colliers, but have to retire, most of their boats sunk. Attempt to storm works by landing parties. This fails because the landing parties are under fire from the concealed guns as soon as they come on deck to get into the boats, also all the way ashore, and particularly on landing.

The fleet have tried to locate these guns with little success but considerable expenditure of ammunition.

Landing parties attack but are beaten off, provided the works have good gorge defense. This I shall attempt later to show is absolutely necessary nowadays.

It is assumed that a good mine defense exists, firing station concealed like Q.F. batteries for defense against torpedo-boat raid.

9.40. Enemy decides to draw off.

10 a.m. Enemy out of fire—has suffered very heavily in men and lighter guns. Ammunition nearly expended. The heavy B.L. in permanent works however got in a few very effective shell just before enemy anchored, and during his retreat, also at one period, when his attention was diverted to the dispersed armament.

Without the dispersed armament the result would have been different. Undisturbed by fire the enemy could land a strong party with guns, and any force of infantry in neighborhood of works could be driven off by gun fire from ships, the guns landed could prepare to support the attack on the gorges of the works.

It is noteworthy, taken in connection with the dispersion now necessary in infantry attack, that a modern battle-ship—*broadside on*—presents a target equal to the infantry of a whole division (8 battalions) drawn up in mass on a front of two companies. *End on* to a brigade in column of half companies.

These to guns with angle of descent, 3°.

To howitzers, angle of descent, 45° the targets appear as follows:—

Broadside on ½ battalion in ¼ column.

End on, (no special infantry formation).

III.

DELIBERATE ATTACK.

This would include combined Naval and land attack. Any attack by the Navy on the coast works, would take something the form of that above described and need not be further spoken of.

The problems to be solved in the defense of our land fronts have received scanty public discussion.

It has been felt that the rear of our coast fortresses was defended by the Home Army, besides a local field force, and that they could not fall by land attacks unless the Home Army were itself defeated in which case the loss of a coast fortress would add little to the general disaster.

Assuming it possible that 30,000 men with guns, could be landed within 20 miles of a coast fortress, 24 hours before a force of 40,000 with guns could be brought up and organised to attack them, the 30,000 could take up a covering position with 15,000 to 20,000 as required leaving the rest to attack the fortresses, which they need as a base of operations where reinforcements, and supplies, can be landed to prosecute the invasion.

The Tugela battles show us that the retaining power of modern weapons enables a body of troops to hold twice their number. This power of course favors in the case under consideration, (1), the enemy as regards beating off relief; (2), the fortress as regards its defense.

It must be assumed that the enemy will be provided with heavy mobile guns corresponding to our 6-in. and under, and the line to be taken up by the defenders of the land face of the fortress will need to be drawn with a radius of about 4 miles from the principal objects to be defended, giving a total length—assuming the line to be semi-circular—of 12 miles and needing at least, 10,000 men with superior mobility and thoroughly well placed.

It is plain that, for the garrison of the fortress to take full advantage of this retaining power, they should thoroughly know the best position to occupy, for all arms, and have frequently practised not merely the occupation of this position, but the receiving of an attack in it, without which weak points cannot be discovered.

Though we may say that such manœuvers are by no means unknown we are far from having attained to the stage above sketched out. In the future, too, guns such as the 6-in., 4.7-in., and 5-in. with 8-in. and 6-in. howitzers should have a more important share of such a defense and the R. G. A., who would man them, have had little or no practice in the work; these should know all ranges which should be also marked, and should where possible do actual practice. In the case of howitzers, it should be by no means hard to practice, as there is no ricochet. The Nation needs to be taught to put up with some inconvenience in order to give its troops a fair chance to attain real efficiency.

To be attacked on the land side of a coast fortress assumes the temporary command of the sea by the enemy. This often involves both flanks of the land defense line being open to enfilade and probably to reverse fire.

The possibility must also be considered of parties being landed in rear of either flank to rush the works, or co-operate in an attack made on that flank by the enemy's field force.

In this connection the open gorges of our modern works are surely wrong; they should of course not have a bank or wall close behind the guns to burst shell, but should have a strong parapet well back.

The question of defending the flanks of the land face is a most serious one. We have in Ladysmith an excellent example, for the position of our troops closely resembled that of our troops defending the land face of a fortress, the shore being roughly the little river and the sea being the open plain to Bulwaan which itself represents the hostile ships carrying heavy guns. With a real coast fortress however the hostile ships would be infinitely more formidable than Bulwaan, and it becomes obvious that the flanks of the line must be protected, not by mere field works, but by works having thoroughly safe bomb proofs, and the positions near the flanks must be thoroughly traversed. All this needs to be done in times of peace.

There was but one position at Ladysmith ; the loss of Wagon Hill and Cæsar's Camp meant the loss of the fortress, and so it would be in case of our coast fortresses.

COMMUNICATIONS.

The natural features of coast fortresses, generally, make communications difficult; the fortress is frequently divided up by one or more rivers. Marshes also are found and water meadows. These though helpful in the defense of the coast works, are of doubtful advantage when we consider the possible need of quickly, as at Ladysmith, reinforcing one flank of our horseshoe defenses from the other.

The low command of the land near many harbors exposes our communication to fire from seaward.

Special arrangements such as light railways, bridges, steam ferries, etc., are necessary, and near the flanks, covered ways should be constructed.

VALUE OF A 2ND POSITION COMMANDING THE 1ST.

This we have found to our cost in the present war. Now that we may hope to have on the land face of our fortresses guns efficient up to 10,000 yards, we should be able so to place them as to render the occupation of the sea face works, impossible by the enemy.

The dispersed mobile 6-in., 4.7-in. and 12-pdr. facing usually seaward, already spoken of, as defeating the purely sea attack, may be able to effect this alone, but if not, some on, or near, the land face can do so.

NAVAL CO-OPERATION.

Assuming the defenses of harbors to remain under military control, we have in our present power of disposing and concealing heavy Q.F. guns a sphere, in which, as shown at Santiago, and particularly at Ladysmith, the Navy can be of the utmost assistance in certain cases to the military, for should damaged or overmatched war-ships be shut up in the fortress, their Q. F. armament can be quickly landed, and disposed for defense, on either face as most required.

GENERAL COAST DEFENSE.

There has always been feared the bombardment of coast towns and hostile landings on the low lying lands on our coasts. We may say that now such things are infinitely harder than of old.

A few years ago experiments were made with a 40-pdr. on a truck, specially arranged to fire from the truck. We have now proved that 6-in. Q.F. guns can be fired from a mobile carriage, and in one hour from the time an enemy was signalled, dozens of such guns, if made ready in peace, could be detrained at the spots most often mentioned in this connection, with some thousands of troops armed with magazine rifles.

Such guns concealed as they now can be, and placed out of range of similar guns on board ship, could surely make the landing of troops and stores impossible, and the advance of troops against them, would be worse than the advance at Colenso. On the other hand, once an enemy has secured a lodgment with a good position facing landwards, he is far harder to dispossess than of old.

In the above, "Thoughts on Coast Defense" it has been necessary to assume more or less absence or failure on the part of the fleet. The question as to whether such absence is probable etc., is not gone into.

PROFESSIONAL NOTES.

ARTILLERY MATERIAL.

Krupp 12-inch, 40 Calibre Coast Defense Gun.

It is stated that this gun is capable of penetrating the thickest and most modern type of armor, forming the protection of ironclads, at any distance at which the latter would attempt to destroy coast defense works. The gun is of special crucible steel; it is formed of a tube strengthened with jackets and coils, and is fitted with the Krupp self-arming breech mechanism. The cartridge-case acts as a gas-check. The gun is fired electrically, or by hand by means of a firing line.

Length of the gun ....12.200 m. (40 ft.)
Weight, including breech-block ....50,300 kg. (49 tons 10 cwt.)

The gun recoils in a cradle; the latter is provided on the sides with two trunnions, which pivot in the mounting cheeks. The recoil of the gun is checked by two hydraulic recoil cylinders, placed on the sides of the cradle, and which act in conjunction with two air-pressure cylinders, the latter running out the gun again in its firing position. The mechanism for elevating the gun and the lateral training gear are worked electrically or by hand, at will, as is also the mechanism for serving the gun with ammunition, and it takes but a few moments to pass from electric to hand working. The elevating device with electric motor and gear, is on the left side of the mounting; for elevating the gun by hand there are provided two hand-wheels, which operate toothed-wheel gearing and a toothed arc, the latter fitted underneath the cradle.

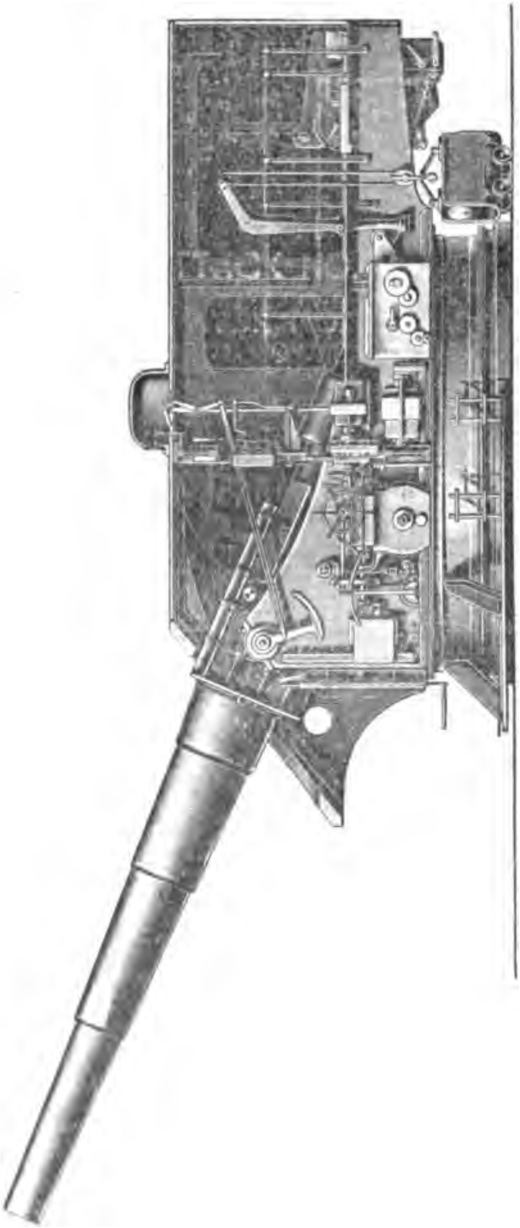
TABLE I.—BALLISTIC DATA OF 12-INCH GUN.

Weight of Projectile.		Weight of Smokeless Powder Charge.		Muzzle Velocity.		Muzzle Energy.		Greatest Range at 22 Degrees Elevation.	
kgs.	lb.	kgs.	lb.	m	ft.	ton-m.	ft.-tons.	m.	miles.
350	771.4	132	291	926	3038	15,250	50,782	20,100	12.49
445	980.8	132	291	820	2690	15,250	50,782	20,200	12.55

TABLE II.—THICKNESS OF ARMOR PERFORATED BY 12-INCH ARMOR-PIERCING PROJECTILES.

Distance of Target from Muzzle.		Weight of Projectile.								Weight of Capped Projectile.			
		350 kg. (771.4 lb.)		445 kg. (980.8 lb.)		350 kg. (771.4 lb.)		445 kg. (980.8 lb.)		350 kg. (771.4 lb.)		445 kg. (980.8 lb.)	
		Thickness of Wrought-Iron Plate Perforated.				Thickness of Ordinary Steel Plate. Perforated.				Thickness of Krupp Steel Plate Perforated.			
m.	yds.	cm.	in.	cm.	in.	cm.	in.	cm.	in.	cm.	in.	cm.	in.
3000	3279	105.1	41.37	110.6	43.54	73.8	29.05	77.4	30.47	43	16.92	44.5	17.51
2000	2186	116	45.66	119.7	47.12	81	31.89	83.6	32.91	46	18.11	47	18.50
1000	1093	127.5	50.19	129.3	50.90	88.7	34.92	90	35.43	49	19.29	49.5	19.48
Near the muzzle.		140	55.11	140	55.11	97	38.18	97	38.18	52	20.47	52	20.47

In the lateral training action the gun turns round a pivot on a platform which revolves on a racer fitted with steel balls. The electric lateral training of the gun is obtained by the action of a lever worked from the firing platform. Lateral training to the right and to the left, from the highest to the lowest speed, and all sudden changes in direction, are obtained by this lever. Three



KRUPP 12-INCH, 40 CALIBRE COAST DEFENSE GUN.

cranks with toothed-wheel gearing engaging the circular rack are provided for training the gun laterally by hand. Besides the usual sighting devices, the firing platform carries a range-finder. The ammunition consists of cartridge cases with projectiles. The charge is driven home in the chamber by a loading device, situated at the extreme end of the firing platform; this is worked electrically or by hand, and is lowered when not in use. All the usual appliances have been provided to insure safe firing. The front part of the shield covering the gun is of hardened nickel steel plates, 135 millimetres (5.3 in.) thick; the rear and cover are of ordinary nickel steel, 50 millimetres (1.96 in.) in thickness.

Normal height of the gun axis	3.200 m. (10 ft. 6 in.)
Elevation	From + 22 to — 4 deg.
Lateral training	Through 360 deg.
Weight of mounting	79,700 kg. (78 tons 9 cwt.)
" shield	90,500 " (89 " 1 ")
" turntable and platform..	64,000 " (63 " 0 ")
	234,200 kg. (230 tons 10 cwt.)
Total weight, including gun	284,500 " (280 " 0 ")

The two annexed Tables I. and II. give ballistic data concerning this gun, and the thickness of armor a 12-inch projectile is capable of perforating when fired normal with the plate.

—*Engineering*, *June*, 1902.

Naval Ordnance.*

BY LIEUTENANT A. TREVOR DAWSON, OF LONDON.

It is true that there are other elements to the fighting efficiency of a warship—speed, invulnerability, and radius of action, but gun-power must always be a dominant factor; there is only one class of naval ordnance suitable, and that must be the best obtainable for that purpose, irrespective almost of financial considerations.

The urgent lesson taught by recent naval warfare is the clamant need for quick-firing, high-powered guns, well protected by armor of the highest resisting quality.

As an instance of the inferiority of some of our comparatively new cruisers, a comparison is made on Table I. of the aggregate energy of the guns of H. M. S. *Diadem*, which was launched in 1896, and of H. M. S. *Hogue*, practically of the same size, now being fitted out at Vicker's Naval Construction Works at Barrow-in Furness. The basis of comparison is the most accurate one of the striking energy which the guns develop, when utilised to the best advantage in a given time. For this comparison the velocities of the 6-inch gun of the *Diadem* and *Hogue* are assumed to be respectively 2,150 and 2,550 feet per second, giving energies, at 3,000 yards range, of 1,416 foot-tons and 1,996 foot-tons, and the velocity of the 9.2-inch gun is 2,720 feet per second, representing an energy of 11,564 foot-tons at 3,000 yards. The rapidity of fire obtained is indicated in the table. The 12-pounder guns and those of less calibre are not included, as their power in determining the issue of an action at long range would be small. The result of the comparison is that the total striking energy of the *Hogue* is almost double that of the *Diadem*.

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* Extracts from paper on this subject read before the *Institution of Mechanical Engineers, England.*

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This is surely a condition which calls for consideration, especially as it is but a fair representation of the increase in power of the guns of today.

TABLE I.

Total Energy per minute of the Guns of two Cruisers fighting at 3,000 yards range.

On 1st Class Cruiser *Diadem* launched in 1896.	On Armored Cruiser *Hogue* launched in 1900.
16 6-inch guns with a muzzle velocity of 2,150 f. s., and firing at the rate of seven rounds per minute, will give a total energy—158,592 foot-tons.	12 6-inch guns with a muzzle velocity of 2,550 f. s., and firing at the rate of nine rounds per minute, will give an energy of 215,568 foot-tons.
	Add 2 9.2-inch guns with a muzzle velocity of 2,720 f. s., and firing at the rate of 3½ rounds per minute, will give an energy—80,948 foot-tons.
TOTAL ENERGY—158,592 foot-tons.	TOTAL ENERGY—296,516 foot-tons.

This comparison is made on the assumption that the service explosive—namely, cordite—is utilised; if, however, nitro-cellulose powder were used in the more modern guns of the *Hogue*, which are equally well designed for its use and would have a much longer life, notwithstanding the increased energy, the twelve 6-inch guns would then have a velocity of 2,800 f. s., and, firing at the same rate, would give an energy of 259,740 foot-tons; and the two 9.2-inch guns would have an energy of 91,966 foot-tons, firing at the same rate and with a velocity of 2,900 f. s. The total energy of the *Hogue* would thus become 351,706 foot-tons, as against 158,592 foot-tons of the *Diadem*—a condition which can be easily realised when manufacturers are given the necessary orders.

THE STRUCTURE OF GUNS.

Two general systems of construction are adopted by most naval powers—in the one, the gun is entirely of steel and in the other of steel and wire. Great stress cannot be laid on the advantages of the one system over the other. At the same time the author is of the opinion that, by the proper application of wire, the highest possible efficiency in construction can be obtained owing to the greater possibility of varying the tension of the wire and tubes with greater theoretical accuracy than is possible with solid steel construction. Steel as wire is much the strongest form of this metal.

THE BREECH BLOCK AND OBTURATOR.

Screw versus *Wedge Plug.*—The wedge system has been adopted generally in Germany and Austria, and many of the smaller countries of Europe and South America. The breech screw form is much more generally utilised, having been accepted by Great Britain, France, the United States, Russia, Spain, Italy, etc. Indeed it may be considered the best form of breech closing device at present in use.

The design of the screw mechanism depends principally on whether it is desired to utilise a metallic case obturator or the plastic pad system. In both cases, however, the form of breech screw used is to a great extent a governing factor, and is of great importance. The type of screw invented by Mr.

Axel Welin, a Swedish Engineer, is the one at present mostly used in modern artillery mechanisms, the British Government having generally adopted it, as well also, as the United States of America, while several other countries have equipments now under experiment.

Metallic versus *Plastic Pad Obturation.*—The objections to the case system are:—(1) The rate of fire is considerably reduced owing to the necessity of handling very heavy cartridges and of withdrawing the case after firing. (2) There is a chance of failure of the case which, when it occurs, puts the gun out of action. (3) The extra weight necessary to be carried on board ship.

All these disadvantages are overcome by the use of a suitable plastic pad form of obturation, an efficient type of which has been evolved after much experiment, by Messrs. Vickers, Sons and Maxim. As a result of its use the 6-inch gun under the most favorable conditions attained a rate of fire of eleven rounds per minute, and the 7.5-inch gun, firing a 200-lb. shot. a rate of fire of 8 aimed rounds per minute. The range was 1,100 yards, and all the shots struck within a metre square of the target. Such results haue never been obtained with mechanisms entailing the use of the case system of obturation, and the author has no hesitation in pressing upon general notice the great advantages obtained by the quick-firing plastic pad system of obturation. The system is equally applicable to guns up to the largest calibre, and a rate of fire of 1 round every 15 seconds has been obtained with this form of mechanism with a 9.2-inch gun, which starting with the gun loaded, means 5 rounds for the first minute of firing. Similar rates of fire from all heavy artillery on board ship would have such a moral effect as to influence the final issue of an engagement.

BREECH MECHANISM.

There are several features common to the breech mechanism of the 12-pounder 3-inch gun, 6-inch quick-firer, and the 9.2-inch and 12-inch breech loader. The mechanism is of the Vickers single movement type, whereby one motion of hand lever or band-wheel performs the separate actions involved in the opening or in the closing of the breech. The one action locks or unlocks the breech plug, swings it in or out of the gun. and in opening or closing actuates the firing gear. In all cases the breech block is of the Welin type, and is mounted upon, and free to turn on a carrier pivoted at the right hand side of the breech. The breech plug, because of its shortness, can be swung clear of the breech without longitudinal travel or curvature within in the breech.

THE MOTIVE POWER FOR WORKING LARGE GUNS WITHIN TURRETS OR BARBETTES.

Hydraulic versus *Steam, Air, and Electric Motive Power.*—The mounting for the gun is as important as the gun itself or as its breech mechanism, because upon the efficiency of its mounting the rate of fire depends. The structure, while extremely mobile, must be sufficiently strong to transmit to the ship the strains that result from the enormous energies developed when the gun is fired. The rapidity and accuracy of aimed-fire are controlled to a large extent by machinery—the elevating and training-gear, the means of supplying the gun with projectiles and powder, the hoist, the rammers, etc. The motive power by which this machinery is operated considerably influences the general efficiency of the mounting, and on this point there is much difference of opinion. The author is much inclined in favor of hydraulic power for the general operation of the mounting, in preference to electricity, compressed-air, or steam.

GUN MOUNTINGS.

After due consideration has been given to strength and adaptability, the principal point in the general arrangement of gun-mountings, as in the mechanism of the gun itself, is to obtain the highest possible aimed rate of fire. The Vickers arrangement admits of the gun being loaded at any angle of elevation, and the loading is quite independent of the laying of the gun. In earlier types it was necessary after the gun was fired to elevate it again to a fixed angle in order to re-load. This not only threw the weapon off the line of sight but took quite an appreciable time to perform, reducing the possible rate of aimed fire in a given time.

9.2-*inch Gun Barbette Mounting*.—On Fig. 23, there is illustrated the equipment for a medium calibre gun specially suited for armored cruisers, which, for its size, has attained the greatest rate of fire of any gun at present mounted in H. M. Navy. This is a 9.2-inch equipment, which is to all practical purposes similar to the guns Messrs. Vickers, Sons and Maxim have now under manufacture, with their mountings, for the Turkish battleship *Messudijeh*. A general description of the mounting is given, as it is of special construction, and is capable of attaining a rate of fire of five rounds per minute. The mounting itself would not produce this extraordinary rate of fire; it is due to the construction of the breech mechanism, in combination with the general arrangement of the mounting. The breech mechanism can be operated, either in opening or closing, in about two seconds, so that very little time is wasted in performing the whole operation. Neither hydraulic nor other mechanical device is needed, as the arrangement of levers gives ample power when worked by hand. The following is a detailed description of the mounting:—

The turntable A is built up of steel plates and angles. The upper roller path *a* is riveted to its under face and machined up true in position. The lower roller path *b* is secured to a machined surface on the floor of the barbette. The rollers BB are provided with flanges at both ends to take the horizontal thrust, and are bound together by a ring of plate steel to which the roller axles are attached.

The turntable is arranged to be rotated either by hydraulic or hand power, the former by means of a three cylinder hydraulic motor F, gearing with a rack E attached to the lower roller path, and the latter by means of handles D situated on the gun platform. The shaft carrying the pinion which gears with the training rack is arranged vertically, and carries two spur wheels f_1, f_2, loosely thereon, to one of which is geared a pinion on the shaft of the hydraulic motor, and to the other is geared a pinion connected to the hand gear. The wheels are connected to the shaft by means of a clutch f_3, so arranged that only one can be in operation at the same time.

A hand brake is provided for securing the turntable when changing from hydraulic to hand power, and *vice versâ*. The hydraulic motor is controlled from the sighting station by means of the hand wheel N.

The gun is mounted on a slide frame S built up of steel plates and angles, provided with bearings upon which the gun slides during recoil. The slide frame is supported by trunnions on bearings *g* in suitable brackets G secured to the upper parts of the turntable.

The recoil presses H, two in number, are fixed to the slide frame. These presses are provided with pistons and rods *h*, the latter being attached to the lug band C secured to the gun, and arranged to slide on a prolongation of the

NAVAL ORDNANCE.

Plate 76.

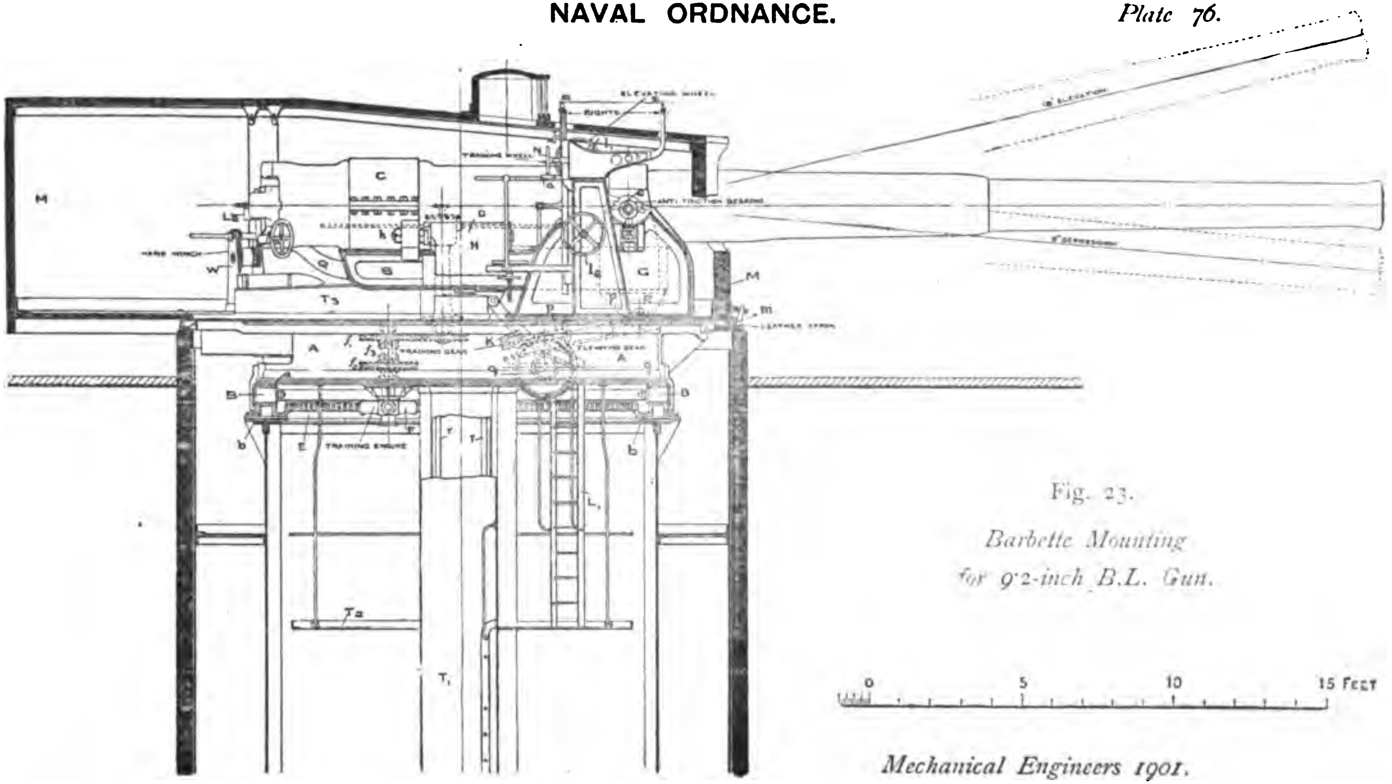


Fig. 23.

Barbette Mounting for 9·2-inch B.L. Gun.

Mechanical Engineers 1901.

slide frame. The presses have an orifice of varying area to allow the liquid in the cylinder to pass from one end to the other during recoil at an approximately constant pressure.

The gun is provided with two rows of recuperator springs placed inside the slide frame, which hold the gun in the firing position, and are of sufficient power to return the gun after fire to the firing position at all angles of elevation. Suitable arrangements are made in the recoil cylinders to prevent the shock when returning to the firing position with the gun horizontal or depressed.

The gun is arranged to be elevated either by hand or hydraulic power. The elevating press P is secured to the turntable below the gun, and is connected by links *p* to the bracket R on the underside of the slide frame. The press is controlled by a lever *n* from the sighting station. Hand wheels are provided at the sighting station for elevating by hand I_1, and also from a secondary position in the gun platform I_2. They are connected by worm and other gearing to the elevating arcs K attached to the underside of the slide frame, two pinions *q* on the worm wheel shaft being geared thereto. An automatic arrangement is provided for disconnecting the hand gear when the hydraulic power is employed.

Automatic sights *ss* are provided on the gun mounting, and an indicator situated at the sighting station shows the position of the mounting relative to ship when training.

An arm Q attached to the gun-slide supports the loading tray L_2, on to which the projectiles are placed for loading. The mechanism of the loading apparatus is such that the projectile always remains parallel with the axis of the gun when the tray with shell is swung into the breech of the gun.

From the under floor of the turntable a trunk T_1 is arranged to extend down into the interior of the ship to the level of the ammunition chambers. It is rectangular in section, and the interior is used as a passage-way and hand-up. The guide rails *rr* for the ammunition hoists are fixed to the outside. A platform T_2 is attached to the underside of the turntable, and revolves with it, from which a ladder L_1 extends to the gun platform; it may be used for carrying the spare ammunition for handing up.

The projectiles are delivered on one side of the gun, and the powder charges at the other, one projectile and two half-charges being conveyed at a time. The shells slide down an inclined through T_3 from the cage to a convenient position at the rear of the gun, from whence they are lifted into the loading tray. The powder charges are carried round by hand to the rear of the gun. Both hoists are worked by hydraulic presses.

The projectiles and powder charges in case of necessity can be raised by hand through the ladder ways to the gun platform.

The mounting is enclosed by a shield M, securely attached to the upper floor of the turntable by plates and angles. It is provided with a sighting hood, and is fitted with a leather apron *m* with screws and brackets for making it water-tight with the barbette.

PROJECTILES AND PROPELLING POWDERS.

The author, from experience, greatly favors the application of a cap to all armor-piercing projectiles for use against modern armor, although the advantages of the capped projectile against comparatively soft armor are not realised to any serious extent. Recent developments in Germany show that they are about to use capped projectiles, and Messrs. Krupp, of Essen, are recommending one of their own construction, which greatly improves the armor-piercing power of the shell.

The types of armor-piercing shell are so numerous that no attempt can here be made to enter into details, but so great is the importance of the really armor-piercing shell from the naval point of view—the penetration of the ship's side when the projectile hits being so supremely important—that no money should be spared to secure the very best obtainable. Really regular and reliable results are only to be ensured by the best forged steel, and not from shells made from castings unforged.

Next in importance to the armor-piercing or semi-armor-piercing shell come the large capacity shells for carrying a high explosive. For this purpose Germany and France, like Great Britain, make use of picric acid, but the Russian Government is utilising gun-cotton in shells up to 11-inch calibre.

In regard to propelling powders for guns there is not much difference of opinion, except in Great Britain, as to the most suitable compound; most countries have adopted or are about to adopt a nitro-cellulose powder. In the use of explosives for heavy artillery, Great Britain, Italy and Austria are only countries which have permanently retained the nitro-glycerine form, whereas Germany, France, Russia, the United States, Spain and Japan utilise nitro-cellulose powder.

And this raises the question of the velocities of guns. The value of increased velocity is shown by the fact of the dangerous space of an object 30 feet high at a fighting range of 2,500 yards being increased by 162 yards in 523 yards when the muzzle velocity is accelerated from 2,500 to 2,700 feet per second. The former velocity is obtained with cordite, and the latter with the nitro-cellulose powder in the 12-inch B. L. rifle.

With the 6-inch guns, the dangerous space for this range is increased from 226 yards to 465 yards for a target 30 feet high, when the velocity is increased from 2,160 to 3,000 feet per second.

These special cases establish the importance of high velocity in modern artillery whereby errors in range need not involve the missing of the target if the guns are of the highest possible energy, which means low trajectory and consequently an extended danger zone.

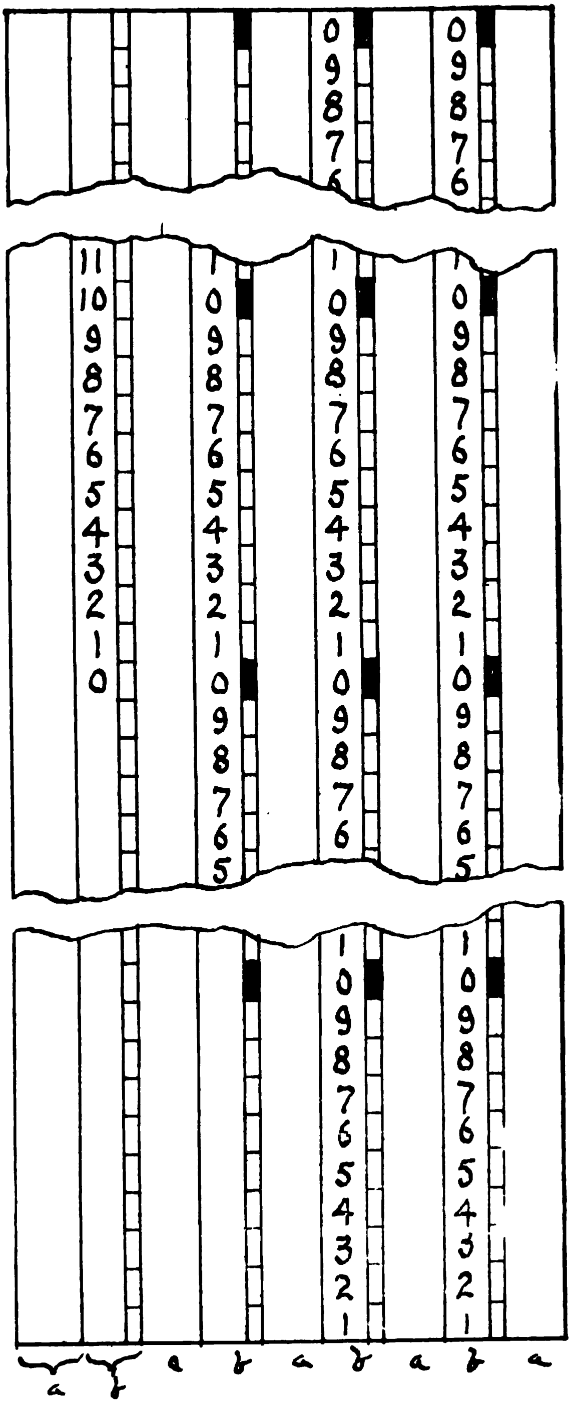
A Handy Computer.

BY CAPTAIN GEO. W. GATCHELL, ARTILLERY CORPS.

In order that coast artillery fire may be most effective it is necessary that there should be no delays which shall reduce rapidity of fire. One essential then is that corrected data shall be furnished fully as fast as the guns can be loaded and aimed or laid.

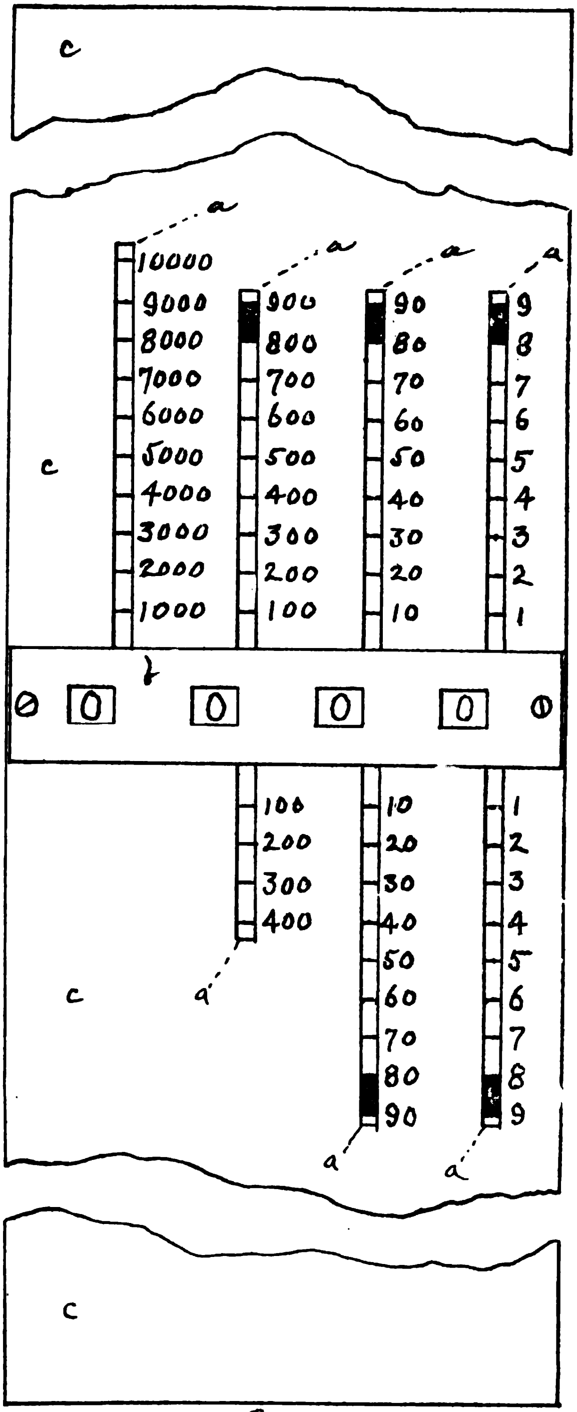
One great source of trouble, involving both error and delay, has been the summation of corrections and determination of the corrected range and azimuth. This has been due to the fact that even the best enlisted men could not add and subtract as quickly as desired, and would make mistakes, especially if they tried to work quickly.

With the idea of finding some way of getting accurate results, and that too more quickly than hitherto, a computing device has been prepared for the use of the 24th Company, Coast Artillery. This device has now been in use about three months, and it is because it has answered its purpose so well that the following description of it is published, so that any one who desires may make one for his own use.



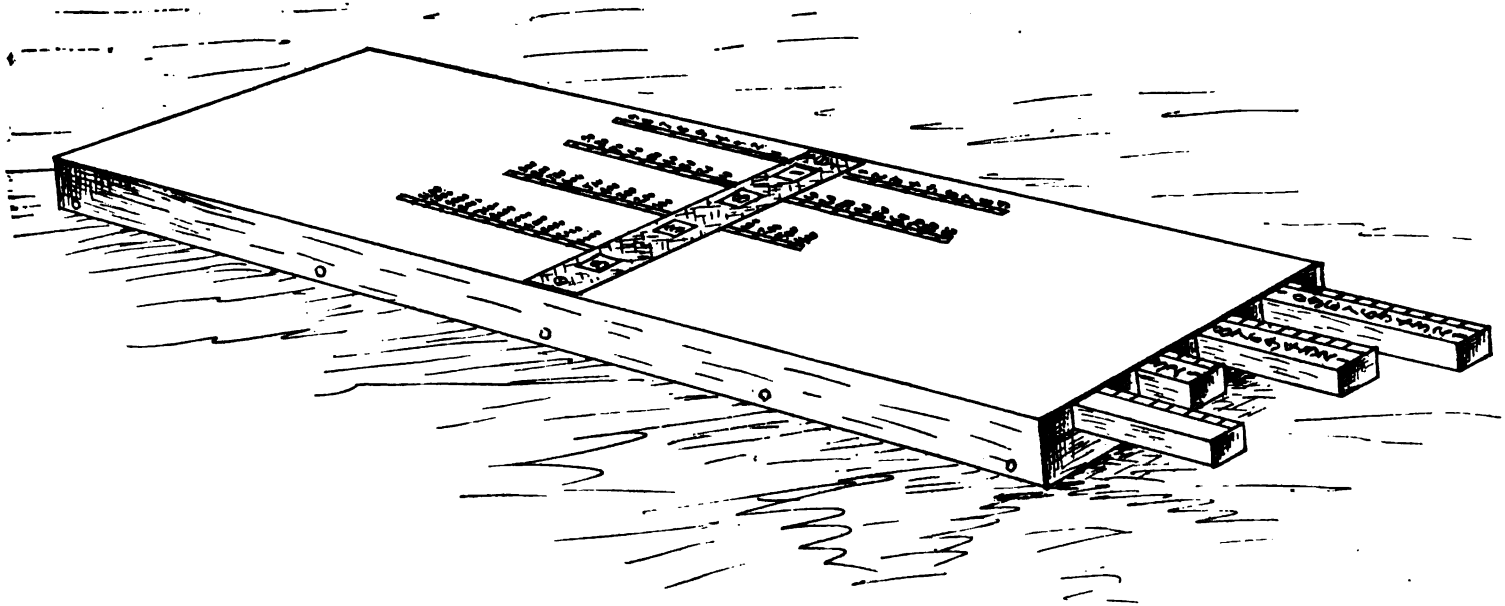
a...a-Fixed
b...b-Moveable

— Fig. 1 —



a--a- Slits.
b— Metal Strip.
c--c- Card-board cover.

-Fig. 2.-



— Fig. 3 —

The device is very simple both in construction and in operation; moreover, any officer, with a little help from a company mechanic, can make one, and any fairly intelligent enlisted man can operate one.

To make the computer, proceed as follows:—

Make, of light wood, nine straight strips, 15″ x 0.4″ x 0.3″ when carefully planed. Fasten five of these to a light wood backing 15″ long, in positions that are parallel, allowing a little over 0.4″ space between them, so that the other four strips can be placed in, and be easily moved back and forth in these spaces.

Mark the movable strips as shown in fig. 1, allowing 0.25″ for height and 0.3″ for width of portion occupied by each figure.

Place all strips in position as shown in fig. 1. Take a piece of card-board long enough to just cover all and wide enough to allow the edges to be secured to the wood backing.

In the card-board cut slits 0.1″ wide, so located that when the card-board is fastened in position, these slits will be directly over the spaced or unfigured portions of the movable strips of wood. Make the length of these slits as indicated in fig. 2, and enlarge them at the proper points so as to uncover the o's at the centers of the movable strips when the strips lie in position with their ends flush with the ends of the wood backing.

Prepare a metal strip as in fig. 2, 0.75″ wide with openings 0.3″ by 0.25″ so cut that when this metal strip is placed across the center of the device its opening will reveal the o's on the movable wooden strips through the openings of the card-board, as indicated in fig. 2.

Secure the card-board and the metal strip, and then mark the card-board near the slits as indicated in fig, 2.

Next prepare a small hand tool for operating the device, by taking an ordinary awl and flattening the point for about 0.2″, being careful not to spread it to a width over 0.1″.

Fig. 3 shows the device completed, and as it might look after use in determining a corrected range.

For determining a corrected range the device is operated as follows:—

Suppose the uncorrected range to be 7684 yards and the following corrections are to be applied:—

△ X for △ V	— 185 yards.
△ X for △ C	+ 169 "
△ X for tide	+ 15 "
△ X for wind	— 23 "
△ X for travel of target	+ 29 "
△ X per difference chart	— 45 "

Take the hand tool and place its point on the mark in the slit opposite 7000 and move the wood strip down till the tool strikes the metal strip. Do the same for 600, 80 and 4 and the range 7684 will appear through the openings of the metal strip.

(Note that movements of the wood strips down give additive results while motion up gives subtractive results.)

Next, to correct for — 185, move up the proper strips for 100, 80 and 5, and 7509 will appear. Then in a similar manner make corrections for + 169, — 23, + 29, — 45, and 7634 will appear. Glancing at the uncovered ends of the wood strips it will be seen that on the units strips one o is in sight at the lower end.

This signifies that one ten is to be carried, — that is that the tens strip must be moved down one space. Doing this the corrected range 7644 appears.

The appearance of one or more o's above or below the card-board cover indicates that the next strip to the left must be moved up or down as many spaces as there are o's showing. In making this correction, or adjustment, of the strips, always work from right to left.

The device and its operation are so simple that any further explanation or example seems unnecessary.

Specifications Regarding Quick-Firing Gun for Heavy Field Artillery.

PREPARED BY THE BETHLEHEM STEEL COMPANY.

JOHN F. MEIGS, ENGINEER OF ORDNANCE.

1. The gun will be Q. F., with shield, carriage, and limber, and, when the latter is packed with 30 rounds of ammunition, the total weight behind the team will not exceed 4260 pounds.

2. The weight of the projectile is 18 pounds, its calibre 3.2 inches and its muzzle velocity would be 1630 feet. This, we estimate, will give a good remaining velocity, and will render the fire of shrapnel effective up to 6,000 or 7,000 yards range, with an elevation of about 16 degrees.

3. The rapidity of fire will depend very much upon the nature of the ground, and upon the quickness with which smoke will be blown away, and upon other conditions beyond the control of the gunner, but with the long recoil provided, and the considerable weight of the equipment, the rate of fire should be very high.

5. Unless otherwise provided, the breech mechanism will be of the continuous type, lever motion, and will be fitted for percussion firing. An extractor will be provided which will throw the empty case clear; and the ammunition will all be fixed.

5. The arrangement of the sight will be as follows:—

(*a*) The sight will not slip down during firing.

(*b*) It will be capable of being re-set by the gunner, or by another number, with one hand.

(*c*) The graduations will be simple, and. will be marked in yards and degrees.

(*d*) The height of the sight can be kept correct by an additional number, if desired, so that the layer's only duty will be to keep the sights on the target, without taking his eye from the line of sight. This special arrangment, in case it is desired to disuse it, will leave the sighting arrangements just as they are usually on guns.

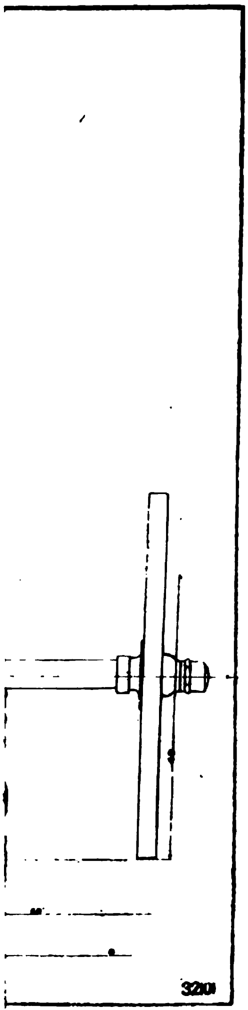
(*e*) A telescope will be provided with movable internal cross hairs, with a magnifying power of about 8 and a field of about 4 degrees, which can be placed on the tangent sight at will.

(*f*) A level, with a prism arranged so that the bubble may be conveniently watched by the layer, will be provided on the top of the sight bar.

6. Open sights, with arrangements for drift, will be provided with the telescope as an auxiliary.

7. The recoil of the gun on the axle, when the gun is level, will be about 60 inches. This recoil will be automatically, as the gun is elevated, diminished to 40 inches at the extreme elevation.

8. Springs will be used for the counter recoil, and will be applied directly to the gun, that is, there will be no fluid under pressure, except during the actual recoil of the gun.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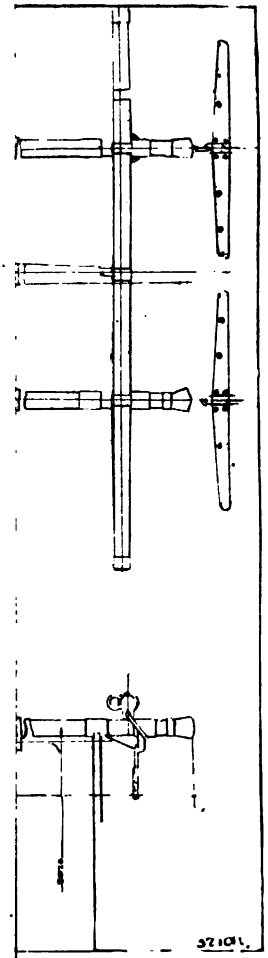
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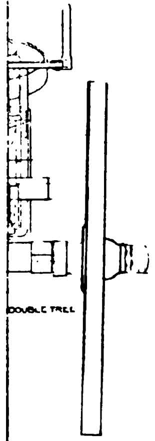
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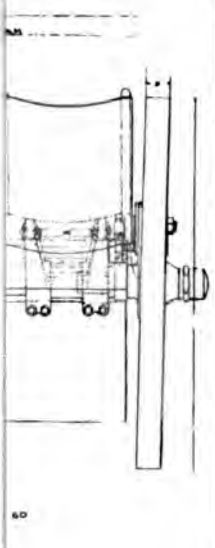
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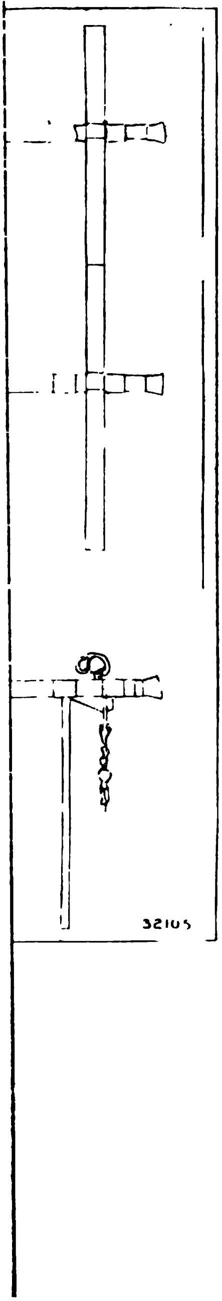
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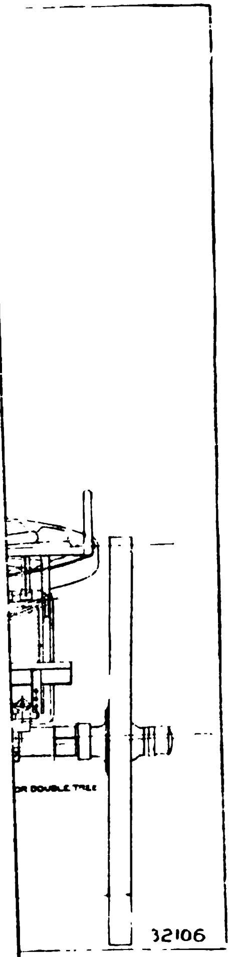
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9. The wheels will be 56 inches in diameter, and will all be provided with roller bearings, and self-oiling arrangements.

10. The traversing gear will admit of 5 degrees motion on each side of the center line.

11. The shields will be of special steel a quarter of an inch thick, and 22 inches wide, extending from 6 to 48 inches above the ground.

12. It is not proposed to carry any ammunition on the gun carriage, unless required, though it could easily be put there.

13. The line of sight of the gun will be from 40 to 44 inches above the ground, and the clearance by the lowest part of the carriage and limber, when limbered up, will be 22 inches.

14. Travelling brakes are provided on the gun carriage, operated by lever from the gunner's seat. There will be two seats provided on the gun carriage, with footboards, unless otherwise desired.

15. The weight of the caisson, packed, will not exceed that of the gun and carriage.

16. The ammunition being fixed, and three or more charges being easily handled, trays are not provided. If, however, these are required, they can be easily supplied.

17. The wheels of the limbers and gun carriages and caissons are all identical.

18. The total weights include the spare parts as shown in the drawings, 107 pounds being allowed on the carriage and limber, and 148 pounds on the caisson and limber.

19. The bursting charge of the shrapnel will be in its base, and no bullets will be in its head.

20. The shells and fuzes will be so arranged that they can be issued and carried fuzed.

21. A time and percussion fuze will be furnished, to act up to the extreme range of the gun, and the fuze will be damp-proof, having a lead cap capable of quick removal covering it.

22. The fuzes will be capable of being set and re-set rapidly, without the use of tools, and will be marked in yards range.

23. The limber is shown with a five horse team, three at the pole and two in the lead. It is believed that these can pull as much as six horses, and, as indicated on the drawings, the five horse team would shorten the length occupied by about 12 feet. It will be observed that if at any time it is desired to do so, two horses could be hitched to the pole, as usual, a socket being provided for a central pole, and the harness and single-trees being all laid out so that the horses could be hitched either way, as desired.

Specifications Regarding Quick Firing Gun for Light Field Artillery.

1. The gun will be Q. F., without shield (unless a less number of rounds of ammunition than we provide be sufficient), and for the complete gun and carriage and loaded limber, when the latter is packed with 36 rounds of ammunition, and when a deduction of 107 pounds is made for special stores, the total weight behind the team will be 3,150 pounds.

2. The projectile will weigh 12½ pounds, and its muzzle velocity will be 1,700 feet. This, we estimate, will give an effective shrapnel fire up to 6,000 ar ds, with 16 degrees elevation.

3. Though this gun is lighter than the heavy gun, its ballistical requirements being less, we would hope to attain as rapid a fire from it.

4. The breech mechanism will be of the continuous motion, lever type, with percussion firing, and an extractor, which will throw the empty case clear.

5. The calibre of the gun will be 3-inches.

6. The arrangements with regard to the sight will be the same as in the heavy gun.

7. The recoil of the gun on the axle, when level, will be 48 inches, and it will be lessened, automatically, to about 36 inches as the gun's elevation increases to its maximum.

8. Springs will be used for counter recoil, and the springs will be applied directly to the gun. That is, there will be no fluid under pressure, except during the actual recoil of the gun.

9. The wheels will be 48 inches in diameter, and all wheels, as in the case of the heavy artillery, will have roller bearings and self-oiling arrangements.

10. The traversing gear will give 5 degrees deflection on each side.

11. The line of sight will be 40 inches from the ground, and there will be a clearance under the lowest part of the carriage, when limbered up, of 18 inches.

12. A travelling brake will be supplied to the limber, to be operated by a man sitting there.

13. The weight of the caisson, packed, will not exceed that of the gun and carriage.

14. Regarding the arrangement of ammunition, the remarks made regarding the heavy artillery will apply.

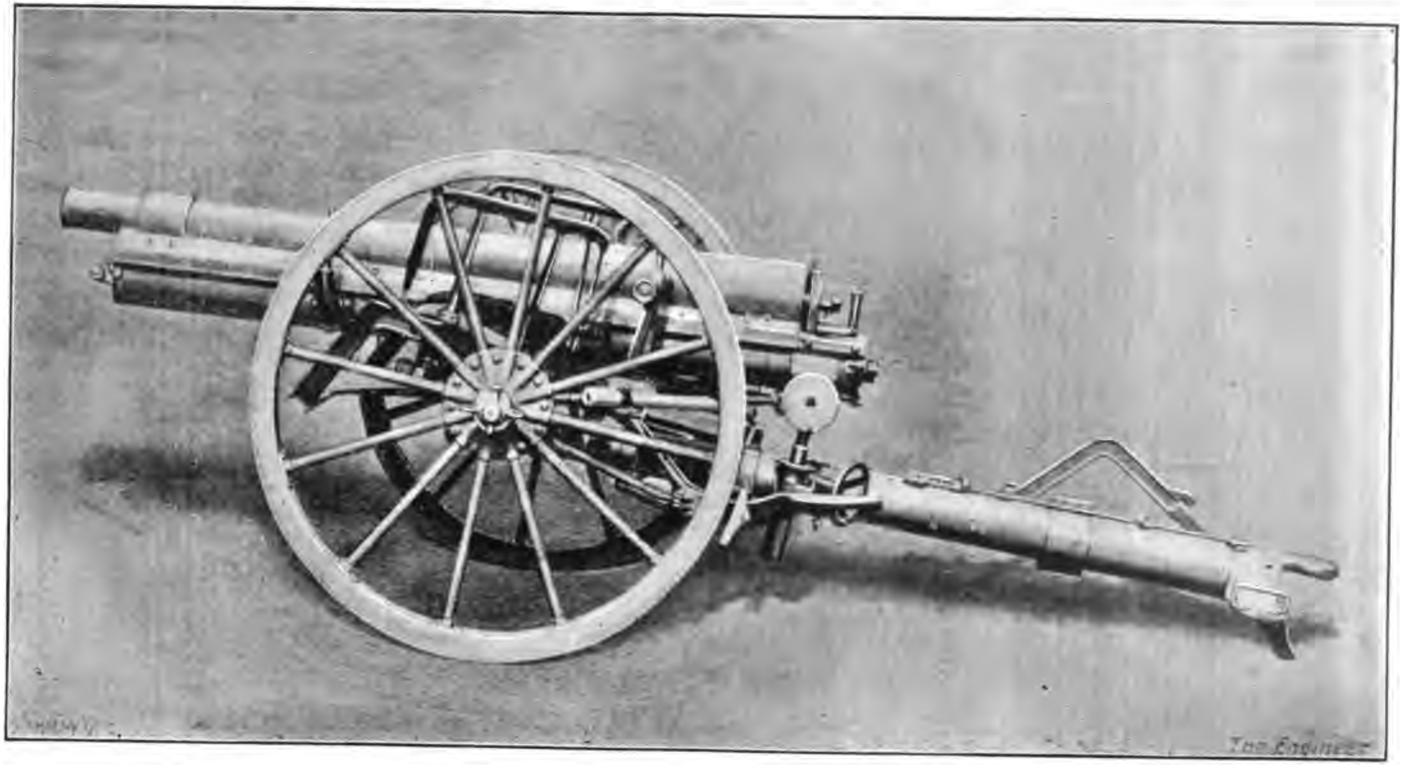
15. The arrangement of the shrapnel. and of the fuzes, together with their limits of burning, will be the same as in the heavy artillery.

The New 15-Pounder Quick-Firing Field Artillery Gun.

We give herewith a full description with illustrations of the new German quick-firing field artillery gun of 3-inch calibre, together with its carriage, which has been adopted for service in the British army, after a series of exhaustive trials at Oakhampton shooting ranges, during which its powers of range and accuracy, as well as the complete success of the arrangements devised for the absorption of the shock of recoil on firing, have been most satisfactorily proved. The difficulties which were encountered at the first onset, as regards the fragile character of the wheels and sundry fractures of the axletree beds and telescopic carriage trails, have been ascertained to be the result only of accidental defects in manufacture, or of local weakness in certain features, and such difficulties have been easily remedied.

A technical description of the gun is as follows:—The material is nickel steel; total length, 90 inches; average weight, 737 pounds; calibre, 3 inches; length of bore, 85.79 inches, or 28.6 calibres; diameter of chamber, front, 3.094 inches, rear 3. 153 inches; length of chamber, 8.11 inches; system of rifling, polygroove, twist increasing from one turn in 60 calibres at breech to one turn in 25 calibres at 5.8 inches from muzzle, remainder uniform, one turn in 25 calibres; length of rifling, 77.67 inches; grooves, number 28, depth .0295 inches, width .237 inches; means of rotation, copper driving band

The gun is without trunnions, and consists of an A tube, over which is shrunk a jacket, secured by a steel screwed ring. Shrunk on the gun are also



The Engineer

The New 15-pounder Field Gun.

two steel guide rings, the lower portion of the front ring being formed to receive the buffer cylinder which is screwed into it. The portions of the guide rings which bear on the surfaces of the cradle are of bronze, and, together with a plane formed on the underside of the jacket at the breech, support and guide the gun during its travel on the cradle. The chamber is slightly coned to facilitate extraction of the cartridge case.

The breech is closed by an interrupted screw, divided so that $\frac{1}{10}$ turn locks or unlocks it. The center of the breech block is recessed to receive the firing mechanism, and is formed at its rear end with an interrupted rim, having four projections which engage in corresponding recesses in the carrier. In the rear face of the block is a groove for receiving the head of the securing pin, and in the rim a recess for the locking bolt. Secured by screws to the right hand side of the breech block, is a screwed toothed segment, in which a screwed pinion of the hand lever engages.

The carrier which holds the breech block, is pivoted to the right side of the breech by the hand-lever pin, and contains the firing mechanism. The rear portion of the carrier is formed to receive a wedge, by means of which the gun is fired, and is provided at the end with a screw cover, which also holds in position a bronze bush, the latter forming a stop for the main spring of the firing mechanism.

The two hinges of the carrier are provided with projections which strike against the short arms of the extractor, and actuate the latter.

On the left of the carrier there is a projection containing a recess for the retaining latch of the hand lever and the locking bolt with spring and cover screw.

Underneath that portion of the carrier which contains the firing mechanism is a safety arrangement by which the striker may be prevented from moving. This arrangement consists of a pin and spring, the latter being actuated by turning a milled head underneath. The letters F—fire—and S—secure—indicate corresponding positions.

The extractor is pivoted near the carrier hinge by the axis pin; at the end of the extracting arms are studs which engage with the rim of the cartridge.

The firing mechanism consists of the firing pin, with striker point, which is screwed on it, and secured by a set screw; a striker guide, over which the main spring is fitted, and a buffer, or "rebound" spring at the rear. The striker is provided with a recess for a safety catch, and behind it another recess for the firing wedge. The hand lever for opening the breech is pivoted to the carrier by the axis pin, the latter being provided with a screw. The handle is recessed to receive the small pivoted lever which works the retaining latch, a spring being provided to insure the latch engaging when the breech is closed. The firing wedge is provided with a lanyard, the latter being fitted with a loop—for placing round the neck—and a wood toggle. The action of the mechanism is as follows:—Suppose the gun to have just been fired, on grasping the handle of the hand lever with the right hand, the lever is pressed in, and the retaining latch is thereby clear of the recess in the carrier so that the hand lever is unlocked. On moving the handle round to the right, the screwed pinion causes the breech block to revolve till the locking bolt moves forward, locking the breech bloch to the carrier. In this position the threads on the breech block are clear of those in the breech of the gun, so that the continued motion of the hand lever causes both to swing round together. When the block is clear of the breech, the carrier strikes the short arms of the extractor, causing the latter to eject the empty cartridge case to the rear. A projectile and a cartridge are then inserted by hand, and on moving the hand lever round to the left, the breech block—which is still locked to the carrier—enters the breech and forces the projectile and cartridge "home." As soon as the carrier comes against the face of the breech, the locking bolt is pressed in, releasing the breech block from the carrier, so that the continued motion of the hand lever causes the block to revolve by means of the pinion, thus closing it securely in the breech. So soon as the hand lever is quite home, the retaining latch, actuated by the spring, engages in the recess in the carrier. On inserting the firing wedge in the recess, and pulling the lanyard until the wedge is clear, the striker is drawn back and the main spring compressed, and at the moment of the wedge leaving the recess the striker is released and the gun fired. By a rebound action the buffer spring brings the striker clear of the point of the breech block To prevent the gun being fired before the breech is properly closed the striker is secured by a securing pin, which is only released when the breech mechanism is properly closed.

Carriage.—The principal parts of the carriage are:—(1) Upper carriage with (*a*) hydraulic buffer, (*b*) running out springs, (*c*) sights. (2) Inner carriage. (3) Elevating and traversing gears. (1): The upper carriage consists of a steel cradle—U section - supported in the center by a pivot, which fits into a socket in the axle of the lower carriage. The cylinder of the hydraulic buffer is contained in the cradle, being screwed at the front into the rear lower portion of the front guide ring of the gun. The cradle is closed by a steel plate containing a guide box for the cylinder. The cylinder contains in front a gland and stuffing-box to prevent loss of liquid.

The rear end of the cylinder is closed by a screw having a filling hole and a filling screw. There is also a screwed recess—in the center—for the reception of a spring spanner. The inside of the cylinder has longitudinal grooves of decreasing width, so that the space for the flow of the liquid varies during recoil, the object of the grooves being to ensure uniform pressure during the travel.

The liquid to be used to fill the buffer cylinder is best pure glycerine—specific gravity 1.26—and the correct quantity is 8¾ pints, the buffer being filled to its capacity. In order to test whether the buffer is filled, the gun is depressed and the filling screw removed, when the glycerine should be seen.

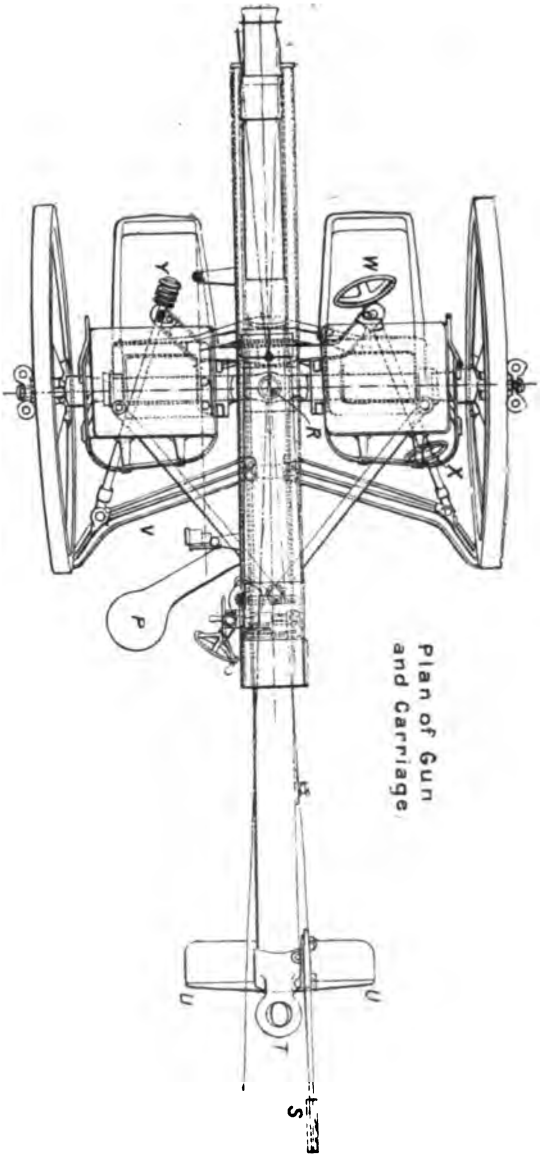
The piston is fixed at the rear end of the piston rod, and in order to control the resistance of the passing glycerine the edges of the front portion are only slightly rounded, whilst the rear portion is well rounded. In the rear end of the piston is screwed a tube closed at the rear end, and provided with grooves increasing in width towards the rear end. Over this tube comes the cover tube of the cylinder on the rebound, the object being to bring the gun gently into firing position after recoil.

Placed in position around and outside of the cylinder are five sets—of four each—steel wire springs which, after having been compressed in recoil—by the action of the front guide ring on the gun—return the gun into firing position. The five sets of running-out springs are separated from each other by four separating discs.

In the front lower part of the front guide ring is screwed the pressure plate, which, by the forward movement of the gun, moves against an india-rubber buffer which also assists in checking the rebound action.

The top sides of the cradle are protected by two lengths of sheet steel, to prevent the entry of either dust or rain, into the open space above the springs.

The two lengths of sheet steel are secured by screws to the guide rings, as seen, and to the plane underneath the breech end of the gun. They are united at the sides, at the breech end of the gun, by a coverplate.



PLAN OF 15-POUNDER GUN AND CARRIAGE

The cradle is sighted on the left side with fore and hind sights, as shown in the illustration. The fore sight consists of a steel pillar, having a pointed apex with a flat portion on the rear side. The sight is fitted to a bracket on the cradle by means of a taper pin and nut.

The rear sight consists of a curved sight bar—U section—provided with a crosshead, having a notched deflection leaf and traversing screw—giving 1½ degrees deflection right and left—and a sight socket which is fitted to a bracket on the cradle by means of a taper pin and nut. The sight bar is graduated on the rear face with a yard and fuse scale, and on the side face with a degree scale. The front face of the bar is provided with a rack engaging with the pinion in the sight socket. The socket has a milled head, and a drum graduated with a yard scale, which are fitted to the pinion spindle, and serves as a means of adjusting the sight bar. A slot in the outer casing, and an indicator point engraved on the socket, are provided to facilitate reading the scale.

An adjustable level is fitted to the sight bar immediately below the crosshead, and is provided with a rack gearing with a pinion and milled head on the sight bar. The level may be used as a clinometer.

The lower carriage consists principally of an axle mounted on two wheels, and a tubular telescopic trail. Two seats, with guard irons, are provided for gun numbers to ride on, and also a seat P for the layer. In the center of the axle is a socket R for the reception of the pivot of the upper carriage. The trail is attached to the axle by two arms in such a manner as not to prevent turning motion of the axle. Outside the front portion is a rib, over which two recesses inside the rear portion are guided in closing the trail, the object being to prevent circular turning motion of the trail. At the front of the trail —under the breast of the carriage—is a space enclosed by a door, which serves for carrying certain small stores required for the service of the gun. At the rear end of the trail is a traversing lever S, which works in a slot, and can be folded down when not in use. There are also handles for lifting, a trail eye T, and a spade attachment U. At the front of the rear portion of the trail there is a strengthening ring containing a hole for a securing key, and at the front portion of the trail are two holes for securing key corresponding to the "long" and "short" positions.

The traversing gear—for fine adjustment—is on the left side, and admits of 3 degrees of traverse either way. It is fixed under the rear cradle, and is actuated by a hand wheel, the whole being supported by a bracket fixed on the head of the elevating screw and by two hollow arms with the axle.

The elevating gear consists of an inner and outer screw, bevel pinion, and hand wheel, the whole being supported in a case, and works in bearings attached to the trail.

Fitted to the trail on each side is an arm V, at the end of which is fitted a steel brake block. To each arm is fitted a steel tube—that on the right being screwed—which are connected by a cross arm over the trail in front. On the right side in front of the seat is a hand wheel W, and another in rear X. On the left side in front of the seat are spring discs Y, by means of which both brake blocks can be put on together when either of the hand wheels is turned.

Dimensions and other Particulars.

Angle of trail, when telescoped out	8½ deg.
" " short	12½ "
Elevation, maximum, of carriage	16 "
Depression	10 "
Space required to turn in	23 ft. 4 in.

Weights.	Cwt.	qr.	lb.
Gun with breech mechanism	6	2	9
Carriage without gun	12	2	0
Limber with 32 rounds ammunition	14	2	0
Wagon with 68 " "	22	1	0
Approximate weight behind traces, gun, and limber, ammunition	33	2	9
Wagon and limber, ammunition	36	3	0
Pressure of trail on ground	141 lbs.		
Weight at end of pole	30 lbs.		

Ammunition and ballistics.—Shrapnel shell.—Description of bursting charge in shell:—F.G. powder in chamber, and about ten cylinders of compressed F. G. powder in central tube. Lead bullets, 260; weight, about 42 to the pound; diameter, about ½ inch; weight of shell filled and fused, 14 lb. 5 oz.; weight of empty brass cartridge case, 1 lb. 7 oz.; charge in cartridge case, 15.2 oz. of ballistic, in cords; maximum time of burning fuse, about 20 seconds; muzzle velocity, at a temperature of 60 degrees Fahrenheit, 1640 foot-seconds; pressure in the chamber of the gun, about 13 tons per square inch. An elevation of 6 degrees 7 minutes gives an approximate range of 3600 yards, under the conditions quoted; whilst the extreme elevation of 16 degrees gives an approximate range of 6700 yards, or nearly four miles. These ballistics, if maintained on service, may be regarded as an admirable exponent of the value of the gun, and of the forethought of our War Department authorities, and of their artillery advisers in securing such a powerful and effective field gun. —*The Engineer*, May 16, 1902.

BALLISTICS: ARMOR AND PENETRATION.

Armor Plates Pierced.

That modern guns and projectiles have defeated armor plate manufactured according to the best modern practice was proven at an interesting series of tests recently held before members of the British Admiralty at Eskmeals, England, under the auspices of Vickers Sons & Maxim, Limited. The principal tests were made on May 23 last, a preliminary trial having been conducted on May 9. A 6-inch and a 12-inch plate were completely perforated several times by means of 6-inch and 7.5-inch Vickers armor piercing projectiles and shells provided with the Johnson cap. The plates were manufactured according to the latest Krupp process, including cementation and subsequent hardening by chilling the face.

The success of the trials was due to the Johnson cap, which is manufactured by Isaac G. Johnson & Co., of Spuyten Duyvil, New York City. Uncapped shots fired under the same conditions as the capped were shattered into fragments upon striking the plate. Another important feature of the tests was the superior showing made by the use of nitrocellulose as compared with cordite.

The Johnson cap has been adopted by all of the powers excepting England. Previous tests have proved its efficacy in guiding shot and shell through armor plate, supporting and protecting the point of the projectile upon the hardened plate and enabling it to find its way into the armor. But never before the Eskmeals tests was a 6-inch capped shot directed against a 12-inch plate. The result of this first test, made on May 9 last, was so satisfactory that it surprised even E. M. Johnson, the inventor, who was present at the time. Consequently a more elaborate series of tests was arranged for May 23, and the entire Admiralty Board, with but one exception, was present to witness the results.

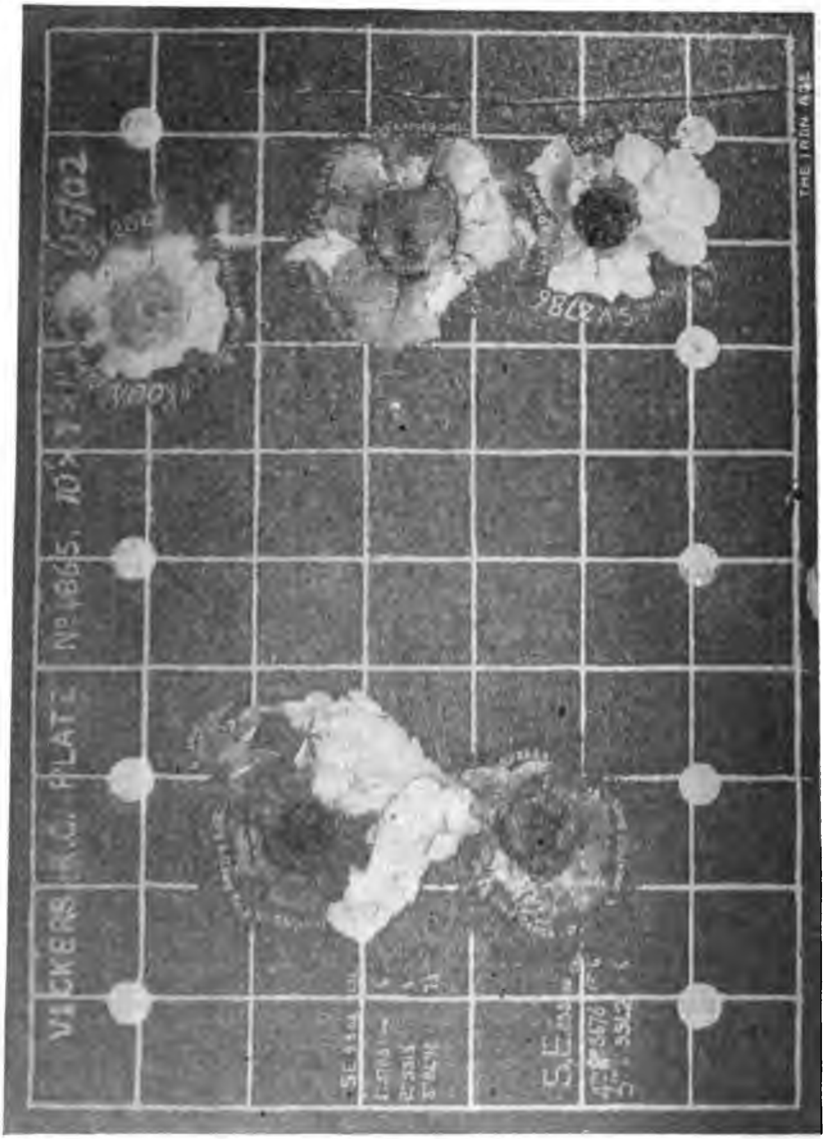


Fig. 1. Showing Effects on 12-inch Plate.

The plates were manufactured according to the British Admiralty specifications and a shot was fired at each plate in full accordance with the Admiralty tests prescribed for the acceptance or rejection of such plates.

On May 9, the date of the preliminary test, three shots were fired at the 12-inch plate. Their effect is indicated on Fig. 1, being the two on the left and the middle crater shown on the right hand side of the plate. As will be noted from official report printed on another page, the first shot completely perforated the plate. The projectile was broken up, the penetration measuring

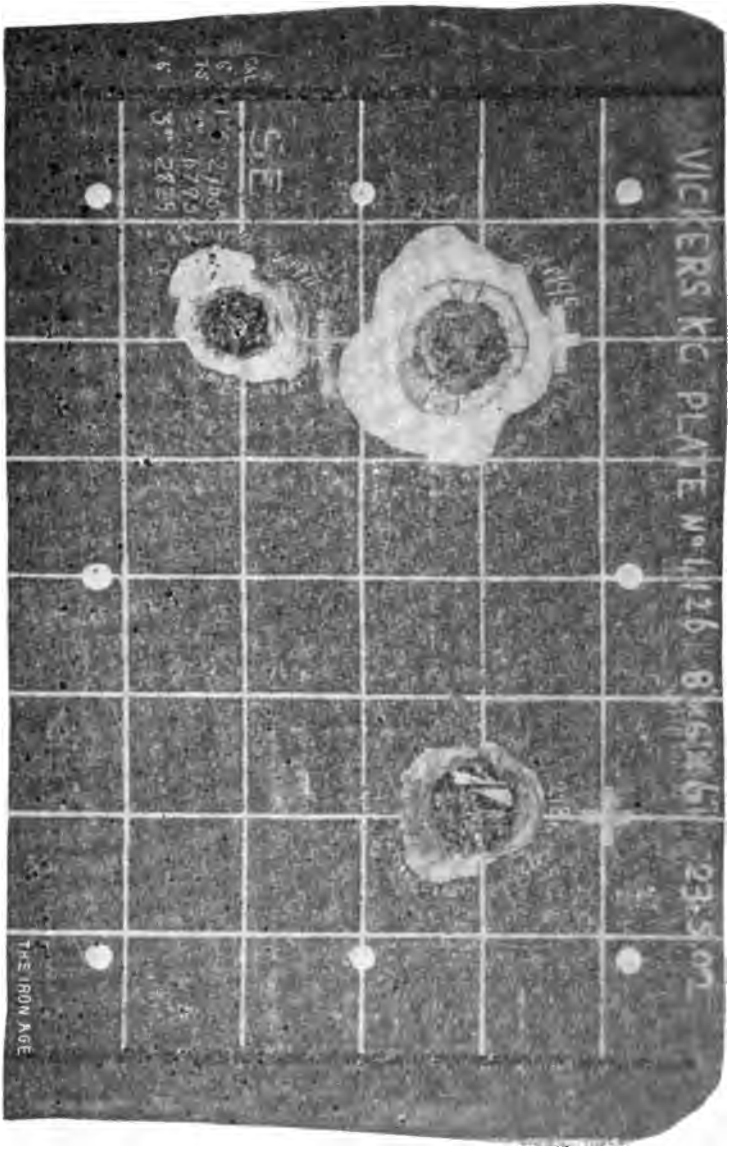


FIG. 2. SHOWING EFFECTS ON 6-INCH PLATE.

18 inches to the base of the shot and 23½ inches after removing the fragments. It was a 6-inch capped shot. The second shot fired was uncapped and was completely broken up, the penetration amounting to about 3¾ inches, the point of the shot remaining fused in the plate, The third attack was made by an

TESTS OF 6-INCH AND 7.5-INCH GUNS AGAINST 6-INCH AND 12-INCH CEMENTED (KRUPP) STEEL ARMOR PLATES.

Table I.—First, Second and Third Rounds Against 11 13-16-Inch Plate.

Date : May 9, 1902. Firing at Eskmeals range for trial of 7.5 and 6-inch Vickers armor piercing projectile fitted with Johnson cap against a 12-inch Vickers K. C. plate, No. 4865. Ordnance No. : 1037A, 6-inch B. L., Mark B. ; and No. 1017A, 7.5 B. L., 50 calibres. Mountings : Naval pedestal. Present : Admiral May, R. N. ; Commander Hope, R. N. ; Major Minchin, R. A. ; Major Bittleston, R. A. ; Mr. Albert Vickers, Lieutenant Dawson, Mr. Malcolm Hay, Mr. E. M. Johnson, and Major the Hon. A. Lambart.

Temperature of charge...80 degrees F.
Thermometer { Dry bulb..48 " / Wet " ..47 "
Barometer ....30.25 inches.

Round.	Charge. Nature.	Charge. Weight. Pounds.	Projectile and fuse.	Velocity. Mean Muzzle Foot-seconds.	S. V. Foot-seconds	S. E. Foot-tons	Ramming. Inches.
1	R. R. 384, Nitro-cellulose.	34	Vickers 6-inch A. P. shot, fitted with Johnson cap, 105 pounds.	2,856	2,799	5,705	41.65
2	Ditto.	34	Vickers 6-inch A. P. shot without cap 100, pounds.	2,880	2,820	5,513	41.55
3	Cordite $\frac{30}{30}$	43	Vickers 7.5-inch A. P. shell, fitted with Johnson cap. 205 pounds.	2,480	2,444	8,492	66.75

ROUND 1.—Completely perforated plate. Projectile was broken up. Penetration measured 18 inches to base of shot, after removing its fragments the penetration measured 23½ inches. Extent of injury by scaling, 18.5 inches H. by 20.5 inches V. No cracks. Diameter of hole, 6 inches. This shot struck exactly in front of a horizontal H. girder, and bulged it back 1⅞ inches, otherwise it would have gone completely through.

ROUND 2.—Projectile completely broken up. Penetration about 3¾ inches, but point of shot remained fused in plate. Extend of injury by scaling, 18½ inches H. by 19 inches V. No cracks. Diameter of portion of shot in hole = 8 inches. There was no trace of bulge at back, or any displacement of backing.

ROUND 3.—Projectile broken up, but all the point portion, including 2 inches of core, remained in plate ; it was not, however, fused in as in Round 2, for a feeler could be inserted in many places around the periphery up to 7 inches from face of plate. Penetration to front end of core was 5 inches ; if therefore, the point preserved its profile, the total penetration would be 9½ inches. Base portion set up and part flowed in molten state into the front of core, molding itself to its contour. Extent of injury, 23.5 inches H. by 21.5 inches V.

NOTE.—After the tests of May 23 the shell of Round 3 became loosened in the plate, so that a feeler could be inserted to the depth of 11¼ inches.

Table II. Fourth and Fifth Rrounds Against 11 13-16-inch Plate.

Date : May 23, 1902. Firing at Eskmeals range for trial of Vickers 6-inch armor-piercing shot fitted with Johnson cap against a Vickers 12-inch K. C. plate, No. 4865. Ordance No. : 1037A, 6-inch, Mark B, Mounting : Naval pedestal. Present : Lord Walter Kerr, Admiral May, Admiral Fawkes, Captain Foote, R. N. ; Colonel T. E. Vickers, Mr. Albert Vickers, Mr. Douglas Vickers, Lieutenant Dawson, Mr. Malcolm Hay, the Hon. S. P. Bouverie, and Major the Hon. A. Lambart.

Temperature of charge ... ...80 degrees F.
Thermometer { Dry Bulb... ... .55 " / Wet " ....54 "
Barometer . ...30 3 inches.

Round.	Charge. Nature.	Charge. Weight. Pounds.	Projectile and Fuse.	Velocity. Mean Muzzle. Foot seconds.	S. V. Foot seconds.	S. E. Foot tons.	Ramming. inches.
4	R. R. 384. Nitro-cellulose.	34	6-inch Vickers A. P. shot. fitted with Johnson cap. Weight, 105.5 lbs	2,841	2,786	5,676	41.75
5	Ditto.	34	6-inch standard A. P. shot without cap. Weight. 100 lbs.	2,887	2,827	5,542	41.7

Three rounds had previously been fired at this plate on May 9, 1902.

ROUND 4.—Shot completely perforated plate, but did not get through the wood backing or skin plate. The shot remained in backing, the rear of base being 9 inches from surface of plate; a feeler could be inserted along the outside of shot to a distance of 16 inches from surface of plate. The extent of injury by scaling was 20 inches H. by 22½ inches V.

ROUND 5.—Shot completely broken up. Penetration 3 inches. Point of shot remained fused in plate. A large piece of shot rebounded and was found 20 in front of plate.

Table III.—Trials Against the 6-inch Plate.

Date : May 23, 1902. Firing at Eskmeals range for trial of Vickers 6-inch armor piercing shot and 7.5 inch armor piercing shell, both fitted with Johnson caps, against a Vickers K. C. plate, No. 4126, 8 feet by 6 feet by 6 inches. Ordnance No. : 1037A, 6-inch, Mark B, and No. 1017A, 7.5-inch, 50 calibres. Mounting : Naval pedestal. Present : Lord Walter Kerr, Admiral May, Admiral Fawkes, Captain Foote, R. N. ; Colonel T. E. Vickers, Nr. Albert Vickers, Mr. Douglas Vickers, Lieutenant Dawson, Mr. Malcolm Hay, the Hon. S. P. Bouverie, and Major the Hon. A. Lambart.

Temperature of charge ....80 degrees F.
Thermometer. Dry bulb....................55 "
Thermometer. Wet " ....54 "
Barometer ....30 3 inches.

Round.	Charge. Nature	Charge. Weight. Pounds.	Projectile and fuse.	Velocity Mean. Muzzle. Foot seconds.	S. V. Foot seconds.	S. E. Foot tons.	Ramming. inches.
1	Cordite $\frac{20}{17}$, Lot 119	12.5	6-inch A. P. shot (Vickers), without cap. Weight, 100 pounds.	2,034	1,995	2,766	41.25
2	Cordite $\frac{30}{30}$, Lot 117	35.3125	7.5-inch A. P. shell fitted with Johnson cap. Weight, 205 pounds.	2,221	2,186	6,795	66.75
3	Cordite. $\frac{20}{17}$, Lot 119	12.94	6-inch A. P. shot (Vickers), fitted with Johnson cap. Weight, 105 pounds.	2,007	1,971	2,829	41.31

ROUND 1.—Projectile broke up, point remaing fused in plate. Extent of injury by scaling, 24 inches H. by 22 inches V. There were no cracks. There were no cracks. There were signs of a bulge at the back.

ROUND 2.—Complete perforation took place; no pieces of shell, except the base plug were found. The size of hole was 8.75 inches by 8.5 inches. Extent of scaling, 14.5 inches H. by 14.5 inches V. The point of shell of this round, weighing 92 pounds, was subsequently recovered, having penetrated 20 feet into sand at the rear of target.

ROUND 3.—Complete perforation took place. Projectile broke up, pieces being found in rear. Size of hole, about 6½ inches. Extent of injury by scaling was 13 inches H. by 14 inches V.

explosive shell from a 7.5-inch gun and fitted with the Johnson cap. The shell became imbedded in the plate, but was not fused. After the successive shots were made on the same plate the shell became loosened so that a feeler could be inserted outside the shell for a distance of 11¾ inches showing that the capped shell nearly, if not quite, perforated the plate.

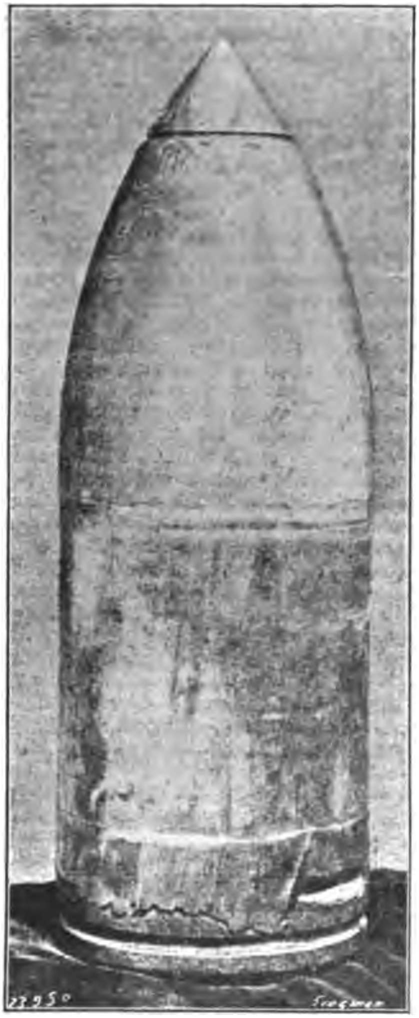


FIG. 3. 6-INCH PROJECTILE AFTER PASSING THROUGH 6-INCH PLATE.

In the tests of May 23 the same 12 inch plate was attacked which has just been referred to. The first shot fired, which was the fourth shot of the entire tests, was a 6-inch 105.5 pound Vickers armor piercing shot fitted with the Johnson cap. It completely perforated the plate, but remained imbedded in the wood backing or skin plate. The fifth shot was a 6-inch standard 100-pound Firth armor piercing projectile without cap and having a striking velocity of 2827 feet. It was completely broken up, the penetration amounting to 3 inches and the point of the shot remaining fused in the plate. A large piece of this shot rebounded and was found 20 feet in front of the plate.

Three shots were directed at a 6-inch plate, Fig. 2, two of which were capped and one uncapped. The first shot was uncapped and was a plate test. It proved the plate to be fully up to standard, as no cracks resulted and the plate showed no bulge in back. It was a 6-inch Vickers 100-pound armor piercing shot, possessing a striking velocity of 1995 feet. The projectile was entirely broken up, the point remaining fused in the plate. The second shot was a 7.5-inch armor piercing projectile weighing 205 pounds and capped, having a striking velocity of 1971 feet. It completely perforated the plate and was recovered later, having plowed 20 feet into the sand in back of the plate. With the third shot, which was a 6-inch capped, the plate was again perforated, the projectile breaking up and pieces being found in the rear. The complete official report is given on pages 190 and 191.

The Johnson cap is of forged steel, cylindrical in form, with its bottom cored out to fit over the nose of the projectile. A small groove is cut around the point of the projectile to allow the cap to be fitted on. The cap is forced on with hydraulic pressure. The groove also prevents a rotation of the cap on the projectile. This groove is plainly seen in Fig. 3.

—*Iron Age*, July 10, 1902.

Guns versus Armor Plates.

No more disquieting news from a naval point of view could be conceived than that which establishes beyond any question the fact that armored plate manufactured according to the latest process, including cementation and subsequent hardening by chilling the face, has been defeated by modern guns and projectiles. A 6-inch plate and one of 12 inches in thickness have been attacked by the Vickers 6-inch and 7.5-inch caliber guns, with capped shot and shell, and on each occasion when these projectiles were used the plate was completely perforated; and, apart altogether from the destructive power of the high explosives admitted in such shells into the interior of a ship through armor-plating, there is the equally disastrous effect of having the hitherto invulnerable water-line plating open to the sea. The ship's crew, the mechanism protected by armor, and the bouyancy of the vessel are consequently endangered, and that, too, by the attack of guns moderate in size and weight and in power, because it is obvious that weapons of higher caliber—9.2-inch and 12-inch—are proportionately more powerful.

The Vickers Company have for several years been experimenting, with most satisfactory results, towards the increase of ballistics in guns, without which even the capped projectile could not avail; and with their 6-inch gun they have succeeded in developing a muzzle velocity of 3,000 feet per second, while for some reason which is not quite explicable our warships have been fitted with weapons in which the velocities have been limited to from 2,160 feet to 2,500 feet per second. The difference is most marked, meaning, as it does, a striking energy at 2,500 yards range of 2,922 foot-tons as compared with from 1,515 to 2,023 foot-tons for the service weapons. Corresponding superiority might easily be recorded in connection with guns of higher caliber, but this one instance will here suffice.

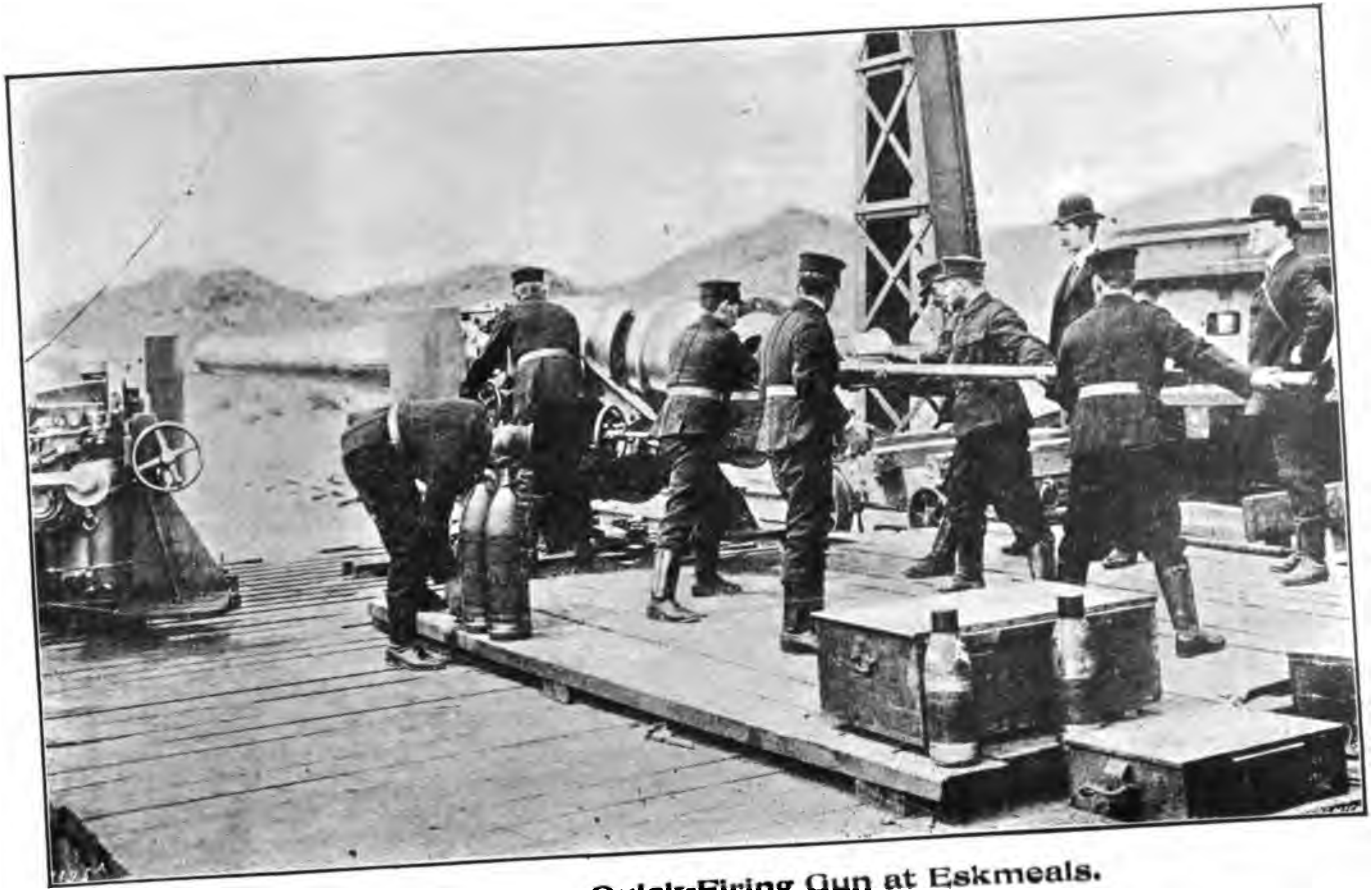
But an important contribution to the defeat of modern hardened armor is the fitting of the shot or shell with a forged steel cap, which experience has proved protects and supports the point of impact upon a hardened plate, and enables the projectile point proper to find its way into the armor. Ten years ago Russia entered upon experiments with a so-called magnetic shot, in which the cap was secured to the projectile by magnetic attraction; but the Johnson cap has proved itself much more satisfactory, and the plates which have been perforated with this projectile, fired from a Vickers gun, establishes the success; an essential feature, of course, is the high-striking energy. The Johnson cap is forged steel, cylindrical in form, with its bottom cored out to fit over the nose of the projectile itself. In the front of our engraving of the gun there will be seen two shells with this cap in position, while on the same platform ordinary projectiles are being placed ready for use by a gunner. For securing the cap there is cut round the projectile a small groove, having at one point of the circumference a slight nick, so that when the cap, by hydraulic pressure, is forced to grip in the groove, the nick prevents any tendency to rotation, which would be prejudicial to the effective absorption of the force of impact by the cap.

As to the effect of the new shot fitted with the Johnson cap, the engravings of the plates carry convincing proof, and clearly establish the triumph of the gun, with new projectile, over the latest plates, and that, too, when developing relatively low velocities. Taking first the 6-inch plate, the third round was fired from a 6-inch gun with a Vickers shot fitted with the Johnson cap, the total weight being 105 pounds. The initial velocity was 2,007 feet per second, and the striking velocity 1,971 feet per second, corresponding to a striking energy of 2,829 foot-tons, with the result that the plate was completely perforated. This in itself is an important result, but more remarkable is the effect obtained from the 7.5-inch gun, which fired the second projectile at this plate. The striking energy here was 6,795 foot-tons, and the result established the immense superiority of this gun for cruisers as well as for the secondary armament of battleships—a point we have already referred to; because, not only did the shell perforate the 6-inch plate completely, but the point of it, weighing 92 pounds, was subsequently picked up in a sand heap at the rear of the target, having, after going through the plate, ploughed its way for 20 feet into this sand. One can quite easily picture the effect of such a shell, with its bursting charge of 6 pounds of explosives, finding its way through the 6-inch belt of one of our many modern cruisers, and exploding its lyddite charge in the interior of the ship.

Referring now to the 12-inch plate, without entering into the details embodied in the official tabulated report, it may be deduced that a capped 6-inch projectile will completely perforate a 12-inch plate if such a velocity as 2,800 feet per second is developed, and this the Vickers gun can easily attain; whereas with uncapped shot, even at this high velocity, the plate undoubtedly triumphs, the extent of penetration being only 3 inches. As for the 6-inch plate, which is much more extensively adopted in our armored cruisers, it has been fully demonstrated that a 6-inch shot, when capped, will effect complete penetration, even with a striking velocity of about 1,971 feet per second; and in the series of experiments carried out by the Vickers' Company there are several examples of such plates being perforated and the shot remaining intact. Even at the risk of repetition, it is proper to point out that the 6-inch projectiles we have been referring to are not shell, but with the 7.5-inch gun on these trials shells were used containing the equivalent of a 6-pound bursting charge, and these completely perforated the 6-inch modern cemented plate with a velocity corresponding to a range of 2,500 yards. It may be thus taken that such a gun using lyddite shell with a Johnson cap could perforate the water-line armor of all the battleships of the Canopus and Duncan classes, as well as all the armored cruisers we are now building, making a very considerable hole and causing much internal destruction; while the 6-inch gun at a range of 2,000 yards could similarly defeat the 4-inch armour of the Kent class.

Since the French, Russian, German, and United States navies have adopted such caps, there is the greater need why our naval weapons should be thus brought into line, and for ensuring that the new guns being fitted to our battleships and cruisers should be improved in their ballistics, while at the same time the 7.5-inch instead of the 6-inch gun should be adopted as the secondary armament of our battleships. This is the more important as these guns are not only of very great power, but attain a high rapidity of fire. At the trials to which we have been referring, a test was made to a ascertain their quick-firing qualities, and it was found that, firing at a target 1,000 yards away, five aimed rounds were discharged within 31 seconds, representing a rate of fire of nine aimed rounds per minute.

—*Engineering*, May 30, 1902.



7.5-inch Vickers Quick-Firing Gun at Eskmeals.

ELECTRICITY.

Electricity in its Application to Submarine Mines.*

BY CAPTAIN JOHN STEPHEN SEWELL, U. S. A.

A system of submarine mines usually involves stationary torpedoes planted under water, anchors for holding them in position, cables for connecting them electrically with the shore, and operating apparatus in a sheltered position on shore. The torpedo itself is usually a metal case, containing a charge of suitable explosive, with necessary detonators, etc. It may, and in shallow water, usually does, rest on the bottom, the metal envelope being in this case sufficiently heavy to act as an anchor. In water more than thirty-five or forty feet deep the torpedo is usually buoyant, and is held in place by a separate anchor and mooring rope. Torpedoes may be purely mechanical in their action; in this case there are usually a number of movable pistons projecting through stuffing boxes at various points, and so arranged that if driven in by the impact of a vessel they will explode a detonator, which in turn will explode the torpedo. It will be readily granted that such torpedoes are dangerous to handle, and are not likely to remain long in an efficient condition in sea water. Again, in some rare instances, use may be made of what might be called self-acting electrical torpedoes, in which a battery and circuit closer, in series with an electrical detonator, are inclosed in the metal case along with the charge of explosive. The circuit closer is supposed to act under the impact of a vessel and the battery does the rest. Some form of dry cell is manifestly the only proper battery for such uses.

In planting self-acting mines it is necessary to have a safety device which will maintain an open circuit, in spite of the circuit closer, until the operations of handling and planting are completed and those engaged in the work have had time to put a safe distance between themselves and the mine. After this, such a torpedo is dangerous alike to friend and foe, and its removal is an exceedingly delicate operation. For this reason, and also because a thoroughly satisfactory safety device is very hard to find, self-acting mines have a very restricted sphere of usefulness.

By far the greater part of all submarine mines are electrically operated from the shore. This follows directly from a consideration of the conditions to be met in devising a system of mines. It is very desirable for a mine to explode automatically when struck by a hostile vessel, but it is equally desirable for it not to explode if it is struck by a friendly vessel; the defense should also be able to explode the mines at will from the shore, in case a hostile vessel comes near but seems likely to miss them. All these things are rendered possible by mines electrically operated from the shore.

It is necessary, of course, to proceed with accuracy and precision in order to attain successful results with such a system. Mines are, primarily, obstructions and not weapons; their principal function is to prevent the enemy from running by the batteries, which experience has demonstrated that he can do if he has a clear channel. They must be located where, if he tries to remove them, he will be detained under the close fire of the shore guns; otherwise he would remove them and then run by. They must be sufficiently numerous to prevent his opening a channel through them by the sacrifice of any reasonable number of vessels sent in to receive an explosion and then turn to one side and sink out of the channel. They must be accurately located and planted in regular order, so that there will be no mistake about exploding the proper mine in judgment firing, and that in case of automatic firing the exploded torpedo may be replaced with the least delay.

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* Paper read at the annual meeting of the American Institute of Electrical Engineers, at New York, May 20, 1902.

It is customary to plant mines in smaller and larger groups; usually more than one torpedo will be attached to a single cable core, and the various cores, as they approach the shore, will be gathered into a multiple cable of several cores. Thus, starting with a cable of ten cores, it should be laid by the most direct line from the operating casemate to a convenient point in the rear of the line of mines it is to serve; there, by means of a large junction box, it would be connected with ten single core cables, each leading to one of a line of smaller junction boxes; at the small junction boxes each single conductor branches into perhaps three other single conductor cables, each of the latter going to a torpedo. By this arrangement when firing is by judgment, which involves some uncertainty as to the actual distance of the hostile vessel from the mines, the defense explodes three charges at once, thus increasing the probability of an effective blow; if, on the other hand, the hostile vessel strikes a torpedo, only the one will explode, and being in contact with its target it ought to be sufficient.

Coming now to the electrical arrangements, if firing were by judgment alone, nothing would be needed but a circuit from the firing battery through the detonators in the torpedo to earth with a firing key in the casemate. Even very defective insulation would not interfere with the working of the system, if the firing battery is enduring and sufficiently powerful. It would interfere with the daily tests, however, because of the variations in resistance which would occur even if no leaks or other defects develop in the torpedo itself. If firing is by contact alone the necessary arrangements are a little more complex.

In order to admit of daily electrical tests—which must include the circuit through the detonators to be of any value—there must be a continuous circuit through the torpedo; it must be of high resistance, so that even if the firing battery is on it cannot fire the mine. There must be a circuit closer in series with the detonators and in parallel with the high resistance. When the mine is struck the circuit closer acts and opens up a circuit of low resistance through the detonators. It is assumed that the detonators are of the type having a continuous bridge of fine wire, surrounded by some fulminating substance, and that it is designed for a relatively large current under moderate emf. This is the most certain and reliable form and is always easy to obtain. If the firing battery is on, the torpedo should explode when the circuit closer acts.

It is desirable, however, to know whether a torpedo is struck, or whether its circuit closer acts from any other causes, even if the mine is not to be fired. Moreover, it is objectionable to keep the cables under such high voltage as is necessary in a firing battery. It therefore becomes desirable to have another battery of very constant emf. always on the circuit. Its emf. and all the resistances in circuit should be so proportioned that normally a tiny current is always flowing; but when a circuit closer acts this current should increase to such a point that it will drop a signal, showing to which triple group the torpedo belongs, and also close the circuit of the firing battery through the corresponding cable core. In case the torpedo is fired, the explosion may cause the circuit closers of neighboring mines to act and thus the whole system might go up, seriatim. To prevent this some device is needed which will allow the firing current to flow long enough to explode certainly the mine that is struck, but which will break it immediately thereafter and keep it broken long enough for neighboring mines to right themselves. It should be remarked here that if ground mines are used for automatic firing the circuit closer must be carried in a buoy, similar in form to a buoyant torpedo, anchored to the ground mine, and having an electrical connection with it; so that, with ground mines, the requirements are the same as with buoyant mines.

It will readily be seen that to accomplish all the above objects a more or less complicated set of apparatus is required. It is a good plan so to arrange the signal drops that when they fall they will close a bell circuit, thus causing a bell to ring continuously until the signal is raised; it is also well for the device which cuts off the firing battery after an explosion to ring a bell as long as the firing circuit is open; this gives reasonable assurance that a mine has exploded, even if in the noise of battle the explosion itself is not heard; pilot lights would do as well as a bell. It is also well to have a very feeble battery for testing purposes only; thus it will already be seen that there may be as many as five separate circuits to provide for in the operating casemate. In addition there may be one more; if a torpedo is struck and fired the end of the cable leading to it will form an earth which, if not cut out, might be sufficiently good to keep throwing the firing battery on; it would so alter the resistances as to interfere seriously with the proper working of the system at any rate. At the triple junction box a fuse could be inserted to carry the firing current, but susceptible of being blown by a more powerful one to be applied as soon as the other mines of the group have righted themselves. If now we assume that a small engine and dynamo are used, in connection with storage batteries, to supply current to various circuits, it will readily be seen that the switchboard problem in the casemate is not simple.

If, in addition to automatic firing, it is desired to use judgment firing, we must be able to switch out the high resistance in the mine, or else have this resistance in the form of the primary of an induction coil, with additional detonators in its secondary circuit; in this case an intermittent or alternating current of high potential and small volume, flowing in the primary, would induce a firing current in the secondary. A whole triple group would then be fired, and the corresponding core of the multiple cable would be detached from the operating apparatus altogether, until such time as the mines could be replaced.

In purely automatic firing the high resistance might be omitted altogether, but then a break in the cable core would give the same indication as a mine in normal condition, and the torpedo itself might be filled with water and sunk to the bottom without the fact being discovered.

The daily tests consist in measuring the resistances of the various circuits and testing all movable parts in the operating casemate. Damage to the system always affects these tests and the expert electrician in charge must learn to infer, from his tests, what the probable nature of the damage is.

It will readily be seen that except for purely judgment firing, the insulation resistance of cables and joints must be very high and must remain so. Details of apparatus actually in use have been omitted in this paper, because they are classed as confidential, but enough has been said to show to an electrical engineer that submarine mining presents some problems that demand serious attention. Not the least of these is the problem of junction boxes which will allow of rapid jointing work, of a quality sufficiently good to withstand submersion in sea water for months at a time. Another serious problem is the cable itself. It takes time to make it. If it is kept in store, either wet or dry, the insulation becomes brittle, and when the cable is unwound from the reels in laying, the insulation cracks. Hitherto the cable used for this purpose has been insulated, taped and armored. While the work has been of a high grade, it seems to the writer that we will have to come to the use of cable having a lead covering outside or the insulation and steel wire armor outside of the lead. Then, as long as the lead is intact, cracks in the insulation will be of no consequence. But this form of cable will be heavier, harder to handle, more difficult to splice, and considerably more expensive than the armored cables without the lead.

Even after the details of a system of mines are satisfactorily worked out, the planting is a very serious matter, and always will be, unless we discover some way of controlling and firing the mines by induction, without electrical connections from the shore, thus eliminating the cable. Possibly the development of wireless telegraphy may ultimately make this possible, but it is not yet in sight.

—*Scientific American Supplement*, July 19, 1902.

The Max Accumulator.

In the manufacture of lead accumulators, the Max apparatus marks a new phase. Up to the present all manufacturers of light accumulators have reproduced, with but very slight differences, plates composed of some sort of a grid pasted with an oxide of lead.

With the new system, we have an accumulator that is not composed of plates. The electrodes have a cylindrical form, which greatly reduces their bulk and the weight of the support of the active material, and therefore diminishes the dimensions of the space occupied by the apparatus.

The first apparatus of the kind, the Phenix accumulator, appeared in 1899 at the competition organized by the Automobile Club of France. The results were excellent from the very start. Since then numerous improvements have been made that have resulted in the production of the present type of Max accumulator, now manufactured by Messrs. Ruphy & Co.

The characteristic of the construction of these elements is that it is exclusively mechanical, and this permits of always obtaining a homogeneous, and consequently cheap, product.

Each electrode is formed of a core consisting of a laminated, antimonous lead wire, surrounded by the active material and insulated from the contiguous electrodes by a jacket of woven asbestos, which prevents the disintegration and fall of the material. Fig. 1 shows the details of the constituent parts of an electrode. *A* is the core of laminated, antimonous lead wire; *B* is the pasted electrode; *C* is the finished electrode, covered with its asbestos jacket.

The method of constructing the electrode permits of obtaining it in any size whatever; hence there is a great elasticity in the construction of the accumulator, and consequently a method of manufacturing it in such a way as to fill the space disposable in the best manner possible. This is an important point where the batteries are to be used on submarine boats, torpedo destroyers, street cars, automobiles, etc.

In Fig. 1 may be seen to the left an electrode 3 inches in length, and, to the right, one 8.5 inches in length, and at the top and around the figure, an electrode, *F*, manufactured as a matter of curiosity, and the length of which greatly exceeds that necessary for all ordinary uses.

Up to the present no definite opinion has been formed as to the true value of cylindrical electrodes. The few experiments that have been made have not been such as to permit of anticipating truly practical results, and the high net cost has prevented the undertaking of a continuous exploitation. Since the manufacture of the Max accumulator is entirely mechanical, however, it enters the industrial domain.

The machine employed for manufacturing the electrodes is particularly ingenious. It permits of forming them and cutting them to the proper length in a single operation.

The paste that is to compose the active material is introduced into a cylinder provided with a piston that is actuated by means of a screw controlled by a series of gears operatively connected with the rest of the apparatus.

The bottom of the cylinder communicates with a special arrangement that permits the lead wire to traverse the bottom of the press and become covered with a coat of properly compressed paste. At the exit there is a cover which, performing the role of a draw-plate of variable section, allows the finished electrode or the wire alone to pass according to requirements.

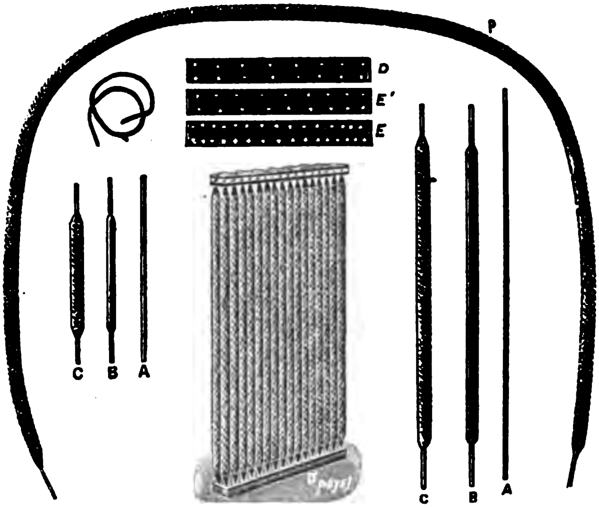


FIG. 1. MAX ACCUMULATOR ELEMENTS.

The wire has a rectilinear and uniform motion regulated by nippers operatively connected with the rest of the apparatus. In front of the cover there is a pair of shears that cuts the wire to the proper length.

The operation of manufacturing an electrode is very simple. The wire, drawn by the nippers, enters the bottom of the cylinder and becomes coated with paste. The motion continuing, the cover opens to permit of the passage of the finished part of the electrode. The piston of the cylinder advances in order to keep the pressure constant, and the pasted portion soon having a proper length, the cover closes and permits of the passage of the wire alone. At this moment the shears cut the latter, and an opposing spring brings the entire movable system back to its initial position in order that the same operations may be begun anew. The machine that performs this work produces about forty pasted electrodes 8.5 inches in length and 0.23 of an inch in diameter per minute, or the equivalent, if other dimensions be desired.

After being dried, the electrode thus obtained is covered by means of a special loom with a woven jacket of asbestos, which is very strong and which acts as an insulator. Blue asbestos is employed by preference.

The electrodes thus finished are afterward assembled and their ends soldered to strips, *D*, *D′* (Figs. 1 and 2) of antimonous lead, which are incased between ebonite pasted electrodes. All these strips of like polarity are then soldered respectively to the terminal lugs, *L* (Fig. 2).

The connections of the accumulators with each other are made either by soldering the lug, *L*, of one element to the lug, *L*, of the following one, or by binding posts of antimonous lead that are used to clamp flexible lead connecting ribbons to the lugs, thus forming very convenient and easily dismountable connections. *P* (Fig. 2) is the hard rubber jar containing the finished element.

In order to permit of an easier dismounting of the elements, the electrodes are arranged in still another manner. The surfaces, such as *D* and *D′*, are composed of thin plates of lead and ebonite placed alternately and corrugated in such a way as to fit into one another. These plates serve as connections at the extremities of the different electrodes of the same polarity, and are joined by a system analogous to that used in the preceeding mounting.

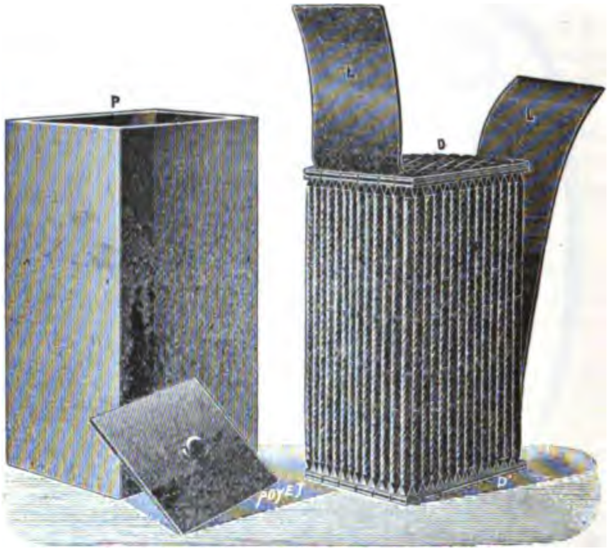


FIG. 2. FINISHED ELEMENT AND CONTAINING JAR.

As may be seen from what precedes, the preparation of the electrodes and the system of mounting them in nowise resembles the mode of construction of other light accumulators. As the support of the active material is of laminated antimonous lead, it is absolutely refractory to electolytic action.

Since the active material is prepared in an exclusively mechanical manner and is placed around the core of the electrode under a considerable and constant pressure, there is a perfect homogeneousness in the construction, as well as great solidity. The cylindrical form prevents any buckling through electrolytic action, and permits, in a certain measure, of operating the apparatus at high rates of current discharge without any danger of buckling. On the other hand, the symmetry of construction of the electrodes permits of effecting an inversion of the elements. This is a valuable resource for restoring capacity when, from use, the active material is no longer adherent and the constants of the apparatus become low.

The specific capacity is particularly interesting. Let us here consider some practical figures; that is to say, such as the manufacturer is capable of guaranteeing for an economic number of discharges. We do not purpose, in fact, to speak of special tests made with private apparatus constructed for lecture courses or competitions.

It is a question here of figures that can be maintained in a continuous discharge.

Capacity in ampere-hours.			Weight of the electrodes.		Weight of the complete element.
10 h.	5h.	3h.			
34	30	26	3.87 lb.	7 lb.	(1)
116	105	01	13.5 "	22.1	(2)
238	210	182	27.1 "	43.34	(3)

As the slight internal resistance of the apparatus permits of maintaining an average voltage of 1.9 volts at the terminals during the discharge, we see that:

No. 1 gives 6.9 watt-hours per pound of element at a 3-hour discharge rate.

No. 2 gives 7.8 watt-hours per pound of element at a 3-hour discharge rate.

No. 3 gives 7.9 watt-hours per pound of element at a 3-hour discharge rate.

—*La Locomotion.*

Recent Tests of the New Edison Battery.

Mr. Edison has recently been subjecting the storage battery invented by him to some very severe tests, to try its endurance under the hard usage which automobile batteries are usually given. The jolting of the automobiles has very serious effects upon the old style lead cells, causing the soft plates to buckle, and the batteries to deteriorate very rapidly. For several months Mr. Edison has subjected one of his new batteries to the action of a jarring machine, which, working by an eccentric, would lift the battery and let it down suddenly, giving it a jar similar to what it would receive on an automobile or a wagon running rapidly over a rough road. It is said that the constant bumping, instead of disturbing the working power of the battery, actually improved it. A lead sulphate battery would have been put out of service by such treatment in a short time.

Other tests of the endurance of the battery have been made which go to show its superiority over the old styles. An 85-mile run was made over a comparatively level road, without recharging the battery. The limit of distance which an electric vehicle usually runs before being recharged is from 20 to 30 miles.

A recent test was made on a battery weighing 332 pounds which propelled a wagon weighing 1,075 pounds 62 miles without recharging, the speed at the end of the run being 83 per cent of the starting speed.

Mr. Edison is now engaged in making a series of tests on automobiles at his factory. Five machines are to be run 5,000 miles each, over rough country roads, each machine having its battery recharged at the end of every 100-mile run. The machines are to be sent at the top of their speed, wherever it is possible to do so.

The principal points of superiority claimed for the new battery are: Ability to do two and one-half times as much work, weight for weight, as the lead sulphate battery; ability to stand overcharging, complete discharging, and even discharging in the reverse direction, without injury; great length of serviceable life without deterioration, and, above all, the fact that the battery can be made and sold cheaper than the old styles. Mr. Edison has created no little stir, recently, by making the prediction that not only will electrical vehicles soon take the place of horses for all commercial purposes, but that in time the storage battery will be employed to furnish the motive power to trains, steamships, street cars, and in every situation where steam or electric power, other than that from storage batteries is now used.

—*The Engineer*, Cleveland, July 1, 1902.

The Collins Wireless Telephone.

BY A. FREDERICK COLLINS.

There are at least five different methods by which articulate speech may be transmitted electrically without connecting wires between two given points. The first and oldest of these is by conduction through land and water. In this system four conductors are earthed, two at the transmitting and two at the receiving end. In this way a portion of the current, passing through the transmitting circuit, is shunted by means of the earth between the instruments and acts upon the receiver, since this path offers the least resistance.

As early as 1825 James Bowen Lindsey operated a system of wireless signals by this method, but by substituting a telephone transmitter for a telegraphic key and a telephone receiver for the galvanometer, speech may be as easily sent as a signal. This is usually the first method suggested to the inventor seeking to transmit articulate speech without wires, but a very few quantitative tests will show that the limitations appear almost before its commercial value begins.

The second and most beautiful form of wireless telegraphy is due to the effects of mutual induction or the magnetic lines of the force exerted by one coil of wire on another placed in the same field of force by mutual induction. This is the ideal system, since no earth connection either at the receiver or transmitter is necessary to effect transmission, but the action is due entirely to the electric whirls or vortices set up in the ether. In this case the effective distance to which speech may be sent is limited by the number of turns of wire on the coil; their distance apart and the mutual induction will then depend upon the current flowing in the primary. Like the former system, the limits are soon reached.

The radiophone and speaking telephone are two forms employing a beam of light to transmit telephonic messages. A pencil of light is allowed to fall on a mirror fastened to the diaphragm of a telephone transmitter, and by means of lenses the light is focused on a selenium cell at a distance of two or three hundred feet. In series with the selenium cell is a telephone receiver and a battery. When the sound waves of the voice impinge on the diaphragm of the transmitter, its vibrations cause the light to be displaced and its intensity on the selenium cell varied. Now selenium possesses the property of transmitting an electric current with twice the conductivity value when in the light that it possesses in the dark, so that there is a wide divergence of conductivity assured when the constantly varying beam of light falls upon it, and thus articulate speech is reproduced.

The fourth system is that employing Hertzian waves, but as the enormously high-frequency oscillations produced by the disruptive discharge of a high potential current is much too rapid to make itself manifest in a telephone receiver, the oscillation circuit which emits the waves must be damped down by the addition of capacity in the form of Leyden jars or condensers and its relation to inductance sustained by supplementing the capacity with coils of wire until the telephone receiver will respond to a vibration of electric oscillations. This system of wireless telephony offers the most interesting experimental field of investigation, but its functions are so complicated that a very limited distance has yet been obtained with it.

In making some tests in 1899 I found a method by which the disadvantages of the very rapid oscillations set up by a disruptive discharge in free air, as the spark of a Ruhmkorff coil produces, and without resorting to the loading of the oscillating circuit with artificial capacities and inductances, could be overcome. This was accomplished by permitting the discharge to take place in the earth instead of the air. To render this process clearer, let us employ, not only as a mere analogue, but as a similar proposition, the fact that electric oscillations emit electric waves, just as an electrically charged vibrating atom sends forth waves which are likewise of electromagnetic origin formed by the polarization of the ether. Even alternating currents of comparatively low frequency of a few thousand per second will emit long electrical waves in space, as Guarini has shown in his experiments in wireless transmission between Antwerp and Brussels. The length of the waves depends on the periodicity of the oscillations, the oscillations on the inductance, capacity and resistance of the circuit, and these in turn on the constants of the ether.

THE COLLINS WIRELESS TELEPHONE.

The constants of the ether are its elasticity and its density. The elasticity of the ether is not known absolutely, but is measured by its reciprocal or di-electric constant, which is the ether modified by its relations with gross matter, and is called its specific inductive capacity. Ether, when in close proximity with gross matter, apparently assumes a greater density than in vacuo or free air, however paradoxical it may seem ; it is now well known that it is not the conductor or wire joining an electrical circuit which conducts the electricity, but the tube of ether including the wire. The atoms of which the earth is composed are likewise permeated with the ether to a much greater extent than the atoms of gases forming the air. To this condition Tesla has given the name of *bound* ether. Similarly as mediums of greater densities transmit sound waves to greater distances than mediums of lesser densities, so the bound ether of the earth will propagate electric waves of proper length to greater distances than those of the ether-bound air. As an illustration, in the case of sound waves, if a bell is struck in free air and it can be heard at a distance of a mile, it could be heard at a distance of twelve miles if struck under water, for water has a density twelve times that of air; now, when a rapidly alternating current of high potential is discharged into the earth and there allowed to restore the equilibrium, electric waves are emitted and propagated through the earth ; the length of the waves is determined by the frequency of alternation and the distance of propagation will depend upon the density of the medium.

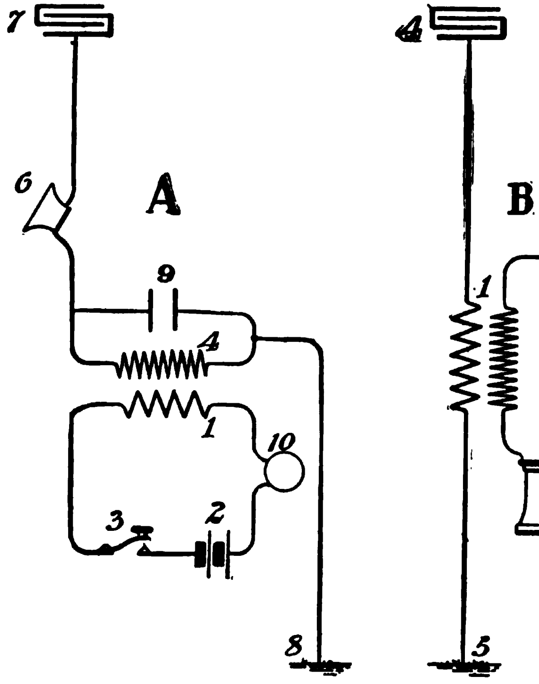


DIAGRAM OF WIRELESS TELEPHONE.

These waves are, of course, normally radiated in every direction, but it has been found possible to reflect them and so make them unidirectional within certain limits. Fig. 1 shows photographically the wireless telephone transmitter the author devised for field work. Fig. 2 is a diagrammatic drawing of the system which has been patented in the United States and Great Britain. In the patent specifications a telegraph key is substituted for a telephone transmitter, as the system is interchangeable and may be used either for wireless telephony or telegraphy with some minor changes and additon.

Referring to Fig. 2, *A* is a transmitter and *B* the receiver. The primary coil is shown at 1, and is in series with the battery, 2, and the key, 3. One terminal of the secondary winding, 4, is connected with a special form of transmitter, 6, and this to a large capacity, 7. The opposite terminal of the induction coil is earthed at 8, and bridged across the terminals of the secondary is the condenser, 9; 10 is a "variator," which will be again referred to. The receiver is quite simple and consist essentially of a transformer coil, 1, a telephone receiver, 2, and a battery, 3; the condenser, 4, of large and equal capacity to that employed in the transmitter, and 5 the earthed terminal.

The action of the instruments is as follows: When the key, 3, closes the primary circuit, the current is automatically varied by a special device, 10, which takes the place of the ordinary interrupter; this produces alternations in the secondary coil, 4, giving rise to high potentials at the terminals, 7 and 8. This potential difference is, however, modified by the transmitter, 6. The surging of the alternating currents through the circuit formed by 7 and 8, emits waves principally at 8, and these travelling with the speed of all other electromagnetic waves reach the earth plate, 5, and, finding an ether path of less density surrounding the circuit, 4 and 5, it traverses that circuit in preference to passing onward through the earth, since the former offers the least resistance. This sets up alternating currents in the transformer coil, 1, and these are impressed on the telephone receiver, 2. The capacity areas, 4 and 7, should be large and of special construction to secure the best effects. The capacities, 4 and 7, are not elevated, and the larger the capacities the greater distance over which articulate speech may be carried without wires.

Both the transmitter and receiver are mounted on tripods providing the operators with testing apparatus almost as portable as a camera. The tests, from the incipiency of the idea of wireless telephony, have been made at Narberth, Pa., where the conditions were all that could be desired. In 1899, speech was transmitted by this system a distance of 200 feet; in 1900 a mile was covered, when with the equipment shown in the engravings articulate speech was transmitted across the Delaware River at Philadelphia, and in 1902 with the instruments placed on hills separated by a railroad, valleys, wooded lands and numerous streams, a distance of three miles was attained. The results have shown the possible commercial value of this system of wireless telephony, which is soon to be perfected for actual use.

—*Scientific American*, July 19, 1902.

WARSHIPS AND TORPEDO BOATS.

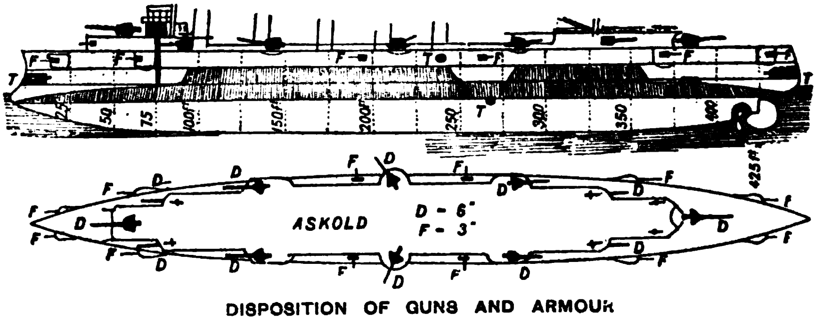
The Russian Cruiser Askold.

The *Askold* is one of that group of 6500-ton Russian cruisers which contains also the *Bogatyr*, *Pallada and Variag*.

Special interest attaches to the ships of this class, in part because they are the result of competition in design, in part because they represent a solid and earnest attempt to continue a type discarded by all other nations. It is true that we have the *Encounter* and *Challenger* in hand, but these ships have neither remarkable speed, nor do they represent anything otherwise than a copy of ancient efforts. The Russian ships, on the other hand, are extremely fast—on trial, at any rate—and all embody something in the way of constructive novelties. The *Bogatyr* type, of which four new vessels are building in Russia, represents the application of the idea we used in the *Diadem*—casemates in a protected cruiser—applied to a vessel little more than half the size. The *Askold* represents, as we shall presently show, if not a new idea in the application of armor, at least internal armor applied more completely than has ever been attempted before. Krupp with the *Askold*, the Vulcan Company with the *Bogatyr*, and the Cramps with the *Variag*, were all put in competition one against the other. The prize—that of the best liked vessel being copied in Russian dock-yards—has gone to the Vulcan Company, but as the *Bogatyr* is as yet hardly complete, the judgment can hardly be regarded as fully final. The fact is that all three are excellent in different ways. There is not room for that all-round excellence in 6500 tons which can be secured in 16,500 tons. So far as they go, the *Variag* represents most speed and least armor, the *Bogatyr* most armour and (probably) least speed—the speed differences being fractional in all three cases, for all are 23-knotters by contract. The *Askold* is more or less a mean between the other two. The data of the three types compared are as follows. The lengths are believed to be between perpendiculars in all cases, and the draughts mean ones:

Name.	Askold.	Variag.	Bogatyr.
Builder	Krupp	Cramp	Vulcan Co.
Length (p.p.)	426½ft.	416ft.	423ft.
Extreme beam	49ft.	52ft.	52½ft.
Mean draught	20¾ft.	20ft.	21¾ft.
Displacement	6500	6500	6500
Guns	All carry twelve 6-in., twelve 3-in. (12-pounders), eight 3-pounders, and two 1-pounders.		
Torpedo	All carry two submerged and four above water, of which one is in the bow, one in the stern.		
Armor—			
Deck, slopes	2in.	3in.	2in.
Turrets (2)	4in.	nil	nil
Casemates (4)	4in.	nil	nil
Conning tower	6in.	6in.	6in.
Hoists	1½in. sloping	1½in.	2in.
Funnel bases	1½in. sloping	nil	2in. vertical
Boiler	Schutz-Thornycroft	Niclausse	Schulz or Dürr
Machinery	3 sets triple-expansion	2 sets triple-expansion	2 sets triple-expansion.
Screws	3	2	2
Coal (normal), tons	720	(?)800	720
Coal (maximun) tons	1,100	1,100	(?)900
I. H. P.	19,000	20,000	19,500
Contract speed	23 knots for all three		

It may here be observed that the *Variag* is reported to draw only 20 feet maximum draught, and all the displacements probably exhibit small inaccuracies. German publications—which ought to know—credit the Bogatyr with only six instead of a dozen 12-pounders, but Russian papers give her the same armament as the others.



DISPOSITION OF GUNS AND ARMOUR

In the matter of general features the *Bogatyr*, has a turret fore and aft. Each carries a pair of 6-inch guns and the forward and after 6-inch guns are also in casemates, variously stated as 3½-inch and 4-inch thick.

Our illustrations indicate the placing of the *Askold's* guns, those of the *Variag* are similarly placed, save that the amidships 6-inch are dispensed with, and the poop and forecastle guns doubled—a very unsatisfactory arrangement in a protected cruiser, as it puts two guns at the mercy of a single shell. Eight of the 12-pounders which are on the main deck in the *Askold* are in the *Variag* placed on the upper deck. The various fires are as follows:

	Broadside.	End-on.
Askold	Seven 6-in., six 3-in.	Five 6-in.. four 3-in.
Variag	Six 6-in., six 3-in.	Four 6-in., two 3-in.
Bogatyr	Eight 6-in., six 3-in.	Four 6-in., four 3-in.

In commenting on these, we may remark that the *Variag's* design exhibits most attention to serving the guns in action—a quality that shows little "on paper"—and the *Bogatyr's* least. Her guns are very mixed up. The *Askold*, having her 12-pounders all on deck together, is, perhaps, little behind the *Variag*. In the matter of the best distribution the *Askold* is an easy first; but the *Bogatyr* has armor as a makeweight, and the *Variag*, as already observed, is the most easily served in action.

In the matter of groups, which mean fire control in action, the ships stand thus: *Variag*, two groups; *Bogatyr*, three groups; *Askold*, five groups. Since however, the more easily they are controlled the more easily are they put out of action, it is impossible to say which is best.

The trial maximum of the *Variag* was 24.6 knots mean for eight hours, and 23.25 mean for twelve hours, at 16,270 indicated horse-power. The *Bogatyr's* trials have not yet been run. The *Askold's* results are as follows: With 125 revolutions and indicated horse-power 20,390, a mean of 23.4 knots for six hours. On a second trial she did a mean of 20,420 indicated horse-power with 126 revolutions, and 23.8 mean speed. The maximum was 23,600 indicated horse-power, and 24.5 knots. Consumption on the first trial was 1.87 lb., and 1.82 on the second. The most remarkable point about the *Askold's* trial was a boiler test given unexpectedly, an account of which appeared in the *Marine Rundschau* last month.

The ship was to proceed on trials, but the weather being foggy, these were countermanded. She has nine boilers, and all but one were out of use. The weather clearing, she received a sudden order to put to sea at full speed, and only two hours later was doing a steady 23 knots, which presently ran up to 24.4 knots. This performance of the Schulz as the Thornycroft boiler is now called in Germany, is very remarkable, and it is curious to reflect that in our battle of the boilers this type has not been mentioned. We, of course, have the Thornycroft in a few small cruisers; but in view of the way in which the Admiralty talk of quick steam raising in and out of season, it is certainly to be deplored that a prejudice against bent tubes should cut the record steam raiser out of the competition.

To resume: The special feature of the *Askold* is her deck. Instead of the usual deck, with inclined engine hatches slightly raised, the *Askold* has a high armor glacis to the bases of her five funnels. Whether the idea is originally Russian or "made in Germany," we cannot say, but it is distinctly good. Though all ammunition passage are now-a-days below the protective deck, there is still considerable importance attaching to the lower deck, and men with leak stoppers, etc., will have to work there in action. This big funnel glacis will go far to ensure freedom for the dense clouds of smoke and steam likely to issue from pierced up-takes. As we have so often pointed out in the Engineer, naval architects, as a class, are terribly prone to overlook all that funnels entail. We do not go quite so far as to say that a ship could be put out of action simply by holing her funnels, 'tween decks, but we are none the less convinced that a ship full of smoke and steam will be quite as handicapped as a ship with several guns knocked out. Such little actual war as has taken place has already pointed one or two nasty lessons in this direction; a big war will probably give more. It took designers a long while to realise that projectiles might hit elsewhere than on big guns or the water line amidships, and we incline to doubt whether there is not as much to learn yet as has been assimilated. —*The Engineer*, July 4, 1902.

The Prinz Friedrich Karl.

On the 21st of June, there was launched at the yards of Blohm and Voss, Hamburg, the armored cruiser *Prinz Friedrich Karl*. This ship is a modification of the *Prinz Heinrich* type with improvements in armament, protection, and motive power, at the expense of only a slight increase in displacement. The principal dimensions are:—

Length	120	metres.
Beam	20	metres.
Mean draught	7.4	metres.
Displacement	9,050	tons.
(Instead of 8,868 tons.)		
Speed	21	knots.

The belt which extends from stem to stern is 2.3 m. wide, 100 mm. thick in the middle sections and 80 mm. thick at the ends. Above, up to the gun deck and for one-third of the length of the ship, the armor is 152 mm. thick; and above this, up to the upper deck, it is 100 mm. thick over one-fifth the length amidships.

The armored deck extends from stem to stern, and is 80 mm. thick in the inclined, and 40 mm. thick in the horizontal portions. The transverse bulkheads are 100 mm. in thickness.

The armament will be as follows:—

4	210 mm. guns in two armored turrets, 150 mm. thick, one fore and one aft, the forward turret being at a greater elevation than the one aft which is on the level of the upper deck.
10	152 mm. guns, of which 6 are in casemates, broadside, on the gun deck, and 4 in small turrets, armor 100 mm. thick, on the upper deck.
12	88 mm. guns.
10	37 mm. guns.
6	torpedo tubes, one for firing straight ahead, one directly astern, and 4 broadside.

Fire along the axial line, ahead or astern, can be obtained accordingly from two 210 mm. guns and four 152 mm. guns; on either broadside, from four 210 mm. and five 152 mm. guns.

The crew will comprise 550 officers and men.

--*Le Yacht*, July 12, 1902.

Naval Strength of Nations.

The navy department has just received information regarding the relative strength of naval powers, which puts Great Britian easily in the lead with more tonnage than any two naval powers combined, and, with the small fleet of Japan added, would have a more effective fighting strength than any three powers. This comparison is based on the ships completed and under construction. The United States' position, according to foreign estimates, should now be as near France as that of either Germany or Russia, both of which have made great strides in late years in naval expansion. What each government is doing towards increasing her navy is given in official records as follows:

France's program of increase is second to that of Great Britain. France probably will continue to be the second mistress of the seas for many years, although, according to Lord Brassey, she is not making such an advance as her position calls for. At present she has building three battleships, each of 14,865 tons displacement, and three of the same type of more than 12,000 tons displacement Her power, however, lies in her armored cruisers, of which class she has under construction a number almost equaling that of Great Britain. Five of this class are of 12,550 tons, one of more than 11,000 tons, five of 10,014 tons and six ranging down to 7,700 tons. She has also two protected cruisers under construction, twenty-four destroyers of 303 tons each and about fifty other torpedo craft of less than 100 tons. The French program contemplates that thirty-seven vessels will be laid during the present year. These are to be four battleships of 14,865 tons each; two armored cruisers, each of 12,550 tons; two destroyers, each of 303 tons; sixteen first-class torpedo boats and thirteen submarine boats. At the end of the present year there will be under construction in all for the French navy 118 vessels.

Germany is following a program of increase agreed on some years ago and designed to place her ahead of Russia and the United States in amount of tonnage. Her fighting ships now building comprise four 13,000-ton battleships, five 11,500-ton vessels of the same class and two of 11,130 tons, four armored cruisers of heavy displacement, and a dozen protected cruisers also being a part of her increase plan. Germany is also building a number of gunboats and torpedo-boat craft. Her navy has made very rapid progress and is creating a large means for future extension. The emperor seems to be accomplishing his purpose to lift his country to a notable place among the maritime powers.

When it comes to Great Britain's stupendous plan of naval increase that of all other nations looks small in comparison. To maintain a naval force equal to that of any other two naval nations combined Great Britain is forced to expend millions of pounds sterling annually on new ships. Three battleships of 16,500 tons and six of 14,000 tons comprise her great fleet of battleships now under construction. Of the armored-cruiser class she is building twenty-four, ranging from 14,000 tons displacement down to 9,800 tons. These vessels are of the highest type. Of the protected cruiser class she is building only six, and of the gunboat class a score or more, while her torpedo-boat increase is limited to half a dozen and her submarine boats to about the same number.

After many years of inactivity Italy has begun to revive her naval efficiency and has now building seven first-class battleships. She is also building a large armored cruiser and a number of other classes of war vessels.

Japan's navy is growing rapidly and includes now under construction a first class battleship and a large number of cruisers and torpedo-boat craft. A new program of expansion recently agreed on provides for four battleships of 15,000 tons each and two armored cruisers of 9,900 tons each and a number of smaller cruisers.

Russia is building five 12,000-ton battleships, five of 13,516 tons and seven varying from 12,000 tons to 5,000 tons. In addition there are thirty cruisers under construction and a number of miscellaneous vessels, including a large fleet of torpedo boats.

Spain is beginning to show signs of some naval activity. It has been recommended by a special board that provision should be made for laying the keels of twelve battleships, four armored cruisers and a number of other ships. Some of her ships now building have been on the ways for more than ten years and are yet far from completed.

What the other governments are doing toward their naval strength is insignificant, compared to the strides that the leading powers are making, although there is no nation with a seacoast making any pretense to supporting a naval establishment that is not building some type of war craft.

Argentina's naval increase proposed, but not yet ordered, consists of two armored cruisers of 8,500 tons.

Austria proposes expending on her navy this year $9,474,000, which does not include payments on vessels now building. These consist of two battleships of 10,600 tons each, three of 8,340 tons and an armored cruiser of 7,400 tons, a protected cruiser of 2,350 tons and some small river boats. She is adding also to her naval equipment by the construction of a 15,000-ton floating dry dock, which is to be built at Pola.

Brazil is devoting some attention to the question of the submarine boat, but, aside from this class, is making no provision for ships.

Chile, the most progressive naval nation in South America, has ordered two battleships to be constructed in England, each to cost, armed and equipped, about $5,000,000. They are to be powerful craft and will have engines to develop 25,000 horse power and capable of 21 knots. Each ship is to carry four 10-in. guns, 15 7.5-in. guns and many smaller rapid-fire guns.

Even Mexico is building a navy.

—*Marine Review*, July 31, 1902.

A Comprehensive Glance at our armored Cruisers.

With the *Jules Michelet* and the *Ernest Renan*, for the construction of which orders have been recently issued, we see completed the series of armored cruisers the construction of which was stopped by the program of 1900.

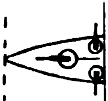
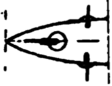
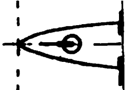
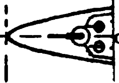
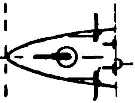
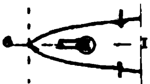
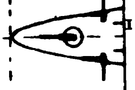
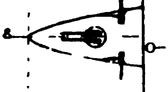
The 24th unit, asked for by the Superior Council, has been omitted. This number was determined upon in 1899, when the principle was enunciated: "24 armored cruisers (3 divisions of 8) are necessary for our naval defense." The program was to be completed January 1, 1906, however, and it is hardly possible for the 24th unit to be in service by that time.

However that may be, a glance at the annexed table will show that our fleet of 23 armored cruisers will comprise 8 different types. Truly a great many.

The modern naval ship of war, in itself a veritable floating machine shop in which steam and electricity play a large and important part, is already sufficiently complex,—too complicated indeed,—as to induce some efforts with a view towards uniformity being made.

If we except a few vessels that need not be considered at present, it will be seen that England produced from 1885 to 1890 seven ships of 5,600 tons and about 19 knots, but now halts in pursuing such a course, and renews her energy and prestige by putting two ships in commission and launching ten in 1901. Other navies will follow her example.

In 1894, we put in commission the *Dupuy-de-Lome*. This cruiser was very much admired abroad, was well armed, well protected and needed only to be increased in size in order to increase its radius of action and make it more comfortable for both officers and men.

showing	ARMOR. mm.		COST Approximate.
	Belt.	Deck.	
1 	10	55	13,500,000
2 	95	65–40	10,300,000
3 	60	85	11,300,000
4 	0–75	55–15	21,800,000
5 	0–100	60–15	20.500.000
6 	120	70	19,000,000
7 	150	50	24,000,000
8 	0–170	2 { 65 50	30,000,000

After that, we cannot fathom the thoughts of the minds that presided over the destinies of the armored cruisers.

Briefly, from 1895 to 1896, the four ships of the *Charner* type were put forth. These are of less displacement and in them turrets for the medium calibre artillery were abandoned and sponsons substituted.

In 1897, displacement increased slightly with the *Pothuau*, without, however, attaining that of our first armored cruiser. The secondary artillery is arranged in casemates.

With the *Jeanne d'Arc* we made an immense advance. But satisfaction was not to be of long duration. The type which follows, to which we owe the *Montcalm* in 1902, is of only 9,500 tons displacement, and has all its 164 mm. guns in casemates, notwithstanding the great inconvenience of such an arrangement.

The *Desaix* type, the sixth, responds to demands of a particular nature. Destined for the colonies, it will assuredly be of considerable value in our distant territories even with its slight displacement of 7,700 tons. These cruisers do not carry large guns. The turret system has been adopted for the protection of the eight 164 mm. pieces, two in a turret.

With an increase of 500 tons in the *Gueydon* (*Montcalm*) type, we come to a new series of five ships of the *Gloire* type. The secondary artillery is increased by two pieces, calibre 100 mm.; four 164 mm. guns broadside, port and starboard, are protected by turrets; the others forward and aft still remain in casemates.

Finally with the *Leon Gambetta*, and others of this type, we have the real armored cruiser, superior to many of the battle-ships of our fleet. These cruisers possess—by having great protection, a well considered and arranged offensive power, sufficient speed, a radius of action suitable for long voyages—all the qualities that are naturally expected and required in a warship for the need and existence of which scouting and making extensive raids form the principal reason.

The heavy artillery and the secondary artillery, with the exception of four 164 mm. guns (two forward and two aft) are in pairs in turrets.

In a word, we will possess in this type five redoubtable ships, similar models of which will follow, we hope, to replace in proportion to our needs the first types of armored cruisers, which can then be utilized as occasion may warrant. —*Armee et Marine*, July 20, 1902.

BOOK REVIEWS.

The Tactics of Coast Defense. By John P. Wisser, Major, Artillery Corps. Hudson-Kimberly Publishing Co., Kansas City, Missouri. 1902. Pp. 232, illustrated. Red Cloth, $2.00.

We congratulate Major Wisser on having produced such an extremely good book on this important subject.

The necessity of such a work is apparent for to students and others interested in this branch of our national defense, under modern conditions of coast and naval warfare, there are few works available in English. General Abbot's standard work is obsolete in many respects; General Maurice's applies more particularly to British needs, and the articles and essays that of late have been written on this subject, both at home and abroad, though containing valuable information, are more or less of a special nature, hence disconnected, and there has been no such co-ordination and logical arrangement of principles as is to be found in the work before us.

We may except, however, the writings of Colonel Mielichhofer of the Austrian Army, with whom students of coast defense are probably familiar. Commencing in 1897, this author has developed the subject in several pamphlets and essays which taken *as a whole* present a scientific arrangement of the principles and a complete system of coast defense.

Major Wisser bases his work largely upon that of Colonel Mielichhofer, and he has done signal service in presenting to English readers the features of that system as applied to our units, guns and conditions. But in addition to this, years of study on the subject and his opportunities for collecting much current information bearing on the general line of his study has enabled him to present in this book a practical and logical exposition of all the questions and principles of the Tactics of Coast Defense in the light of the best authorities of the day.

The author states that the system of tactics here considered contemplates *coast* defense and not merely harbor defense; but we must confess that to us the direct, practical and excellent treatment of the chapters dealing more especially with harbor defense appeals more strongly, and constitutes, we think, by far the most important part of the book.

Commencing with armament in general, the book treats of the systems of artillery, calibers to be used, location of outer and inner mine fields depending on the principles governing their relation to the guns, influence of the width of channel on their location and in deciding on the proper guns needed in the defense, kinds and number of pieces necessary and the uses of the various calibers. The principles of all features of a proper system are thus fully analyzed, the details connected therewith are carefully gone into and worked out by the author for our coast defense guns, and the whole subject is scientifically treated.

Similar considerations and analyses lead to the discussion and determination of the proper sites for the batteries and forts of the defense.

In these discussions, the author assumes that with the new powders our guns will give a M. V. of 2,600 f. s. We fail to see how this velocity can be assumed for our present 35 caliber coast cannon, as with our pieces of present dimensions an initial velocity of over 2,300 f. s. can not be obtained. This is an important consideration as on this assumption depend many of the deductions and conclusions in these and following chapters. We also consider that more accurate terms could be employed than "medium-power" and "low-power" guns, (on pages 33 and 34) in reference to the guns there mentioned, for these guns are not of that nature.

Bombarding range, it is believed, can scarcely be definitely fixed in view of the high angles of elevation now possible with modern naval ordnance and mounts on some of the recent foreign warships.

The chapters on coast artillery material; organization of coast artillery, including general scheme of defense, fire control and direction, garrisons, coast guard corps, etc., and that on instruction and training are excellent. The matter is well presented and arranged and in accordance with modern thought and recognized methods. Two types of fortified harbors illustrating all the principles discussed by the author are given here; one by Colonel Mielichhofer, the other according to Colonel Bujnicki of the Russian Army. The plates are of assistance in showing the application of the principles and help the student in fixing these in mind.

The author then discusses in full detail the battle tactics of coast defense under the heads of blockade, bombardment, attack in its various forms and run past, and having thus considered their features and objects, takes up the defense and treats it similarly and in the same order.

A final chapter on combined naval and land operations completes the book.

In a careful perusal of the book, one is impressed at times with a sense of repetition in some parts. This may be largely due to the detailed treatment of the subdivisions of the subject, but it interferes to some extent with continuity of thought.

Major Wisser is entitled to great credit for the work he has done. His book is a pioneer effort in the field, but it forms an important work, in fact the best we have on this subject and one that all can study with profit. For that very reason we would like to see it free from any inaccuracies that may be noticed in this first edition. It is already used in the course at the U. S. Artillery School, and we have no doubt that it will soon be recognized as the standard work on this subject.

H. Jr.

Das kleine Buch von der Marine. Von Georg Neudeck, Kaiserl. Marine-Schiffbaumeister, Lehrer an der Kaiserl. Marine-Schule zu Kiel, und Dr. Heinr. Schröder, ehem. Lehrer an der Kaiserl. Deckoffizier-Schule zu Kiel. Kiel und Liepzig: Lipsius & Tischer, 1902. Pp. vii+480, with 4 maps, over 850 illustrations and 4 colored plates of Flags. 2 Marks.

This book, for its size, contains a wonderful fund of information. Every one who desires to be fully informed about the German Navy—its history, present organization, personnel and matériel and almost everything connected therewith, can find a large amount of interesting and valuable matter in its pages. It is a practical handbook of everything worth knowing with respect to the German fleet and naval establishment.

The first edition appeared in September 1898; it immediately met with much favor in Germany and elsewhere, and in these few years it has already reached its 45th thousand. This new edition is greatly improved and contains several new features.

To particularize, the volume gives first a short history of the German Navy from the earliest times up to and including the events of the Chinese outbreak, with some remarks on German expansion. In this edition there have been added here many portraits of the ranking German naval officers and officials.

The second part comprehensively treats of its organization and personnel, both ashore and at sea. Then follows a general discussion of naval material, ships, shipbuilding, etc., and a description of all the German warships. To this have been annexed complete tables of the world's navies accompanied by plates giving views ot the ships and diagrams showing armament and armor.

The fourth part treats of the German colonies and acquisitions, the German naval stations and the North Sea canal.

The authors have restricted themselves to facts and, while laying no claim to literary merit, have presented the matter in a direct and practical manner, one of the aims of the book being to enable all who may be interested in German naval affairs to obtain full information, in a concise but readily understood form, on all points that even a layman may desire to know.

The book is fully illustrated by over 850 illustrations which, although somewhat small, are on the whole well-reproduced and add much to its value. There is given also a map of the world showing sea-routes of travel with table of distances, a map of the North Sea canal, one of the German empire and its colonies and a plan of Tsingtau.

The paper is good, type clear and, for its price, the book is well published. We have no doubt that it will continue to gain in favor and secure wider circulation than it already has.

H. Jr.

Organization and Tactics. By Arthur L. Wagner, Colonel and Assistant Adjutant-General, U. S. Army. Fourth Edition. Kansas City, Mo.: Hudson-Kimberly Publishing Co.

Colonel Wagner's work, the American authority on the subject it treats, the text-book at our military schools of application, and the standard in the examination of officers for promotion, is too well known to need a special notice or criticism here. It covers a wide field and is rich in food for thought and study as well as in historical examples; consequently it is also bulky, the one objection that is sometimes raised to it, and it would certainly be desirable to have the *principles* in smaller compass, separate from the quotations of authorities and the historical and other examples. Perhaps, in some future edition, the author may see his way clear to doing this.

The appreciation of the work by the officers of the army and military students in general is indicated by the fact that it has passed through four editions in its comparatively short life, and this for a technical military work in this country is quite remarkable.

J. P. W.

Recueil des Travaux Techniques des Officiers du Genie de l'Armée Belge. Tome III. 1902. Brussels: 46 Rue de la Madeleine. Pp. 209, with 18 plates.

This collection of essays constitutes the third volume of this valuable publication. It was in 1897 that, with the unanimous assent of the Engineer officers of the Belgian Army, it was decided to publish a technical work of this nature in which should appear their studies on subjects connected with the various departments of their arm of the service. The *Recueil* was thus created. We have already had opportunity to speak of the high character of the preceding volumes, and the one before us, by the excellence of its articles fully maintains the standard of its predecessors.

The first essay is an account of *A Modern Hospital*, by G. Vellut Capitaine du Génie, being a description of the new civil hospital of Hamburg—"one most closely approaching the theoretical type of a modern hospital."

Other articles treat of the construction of rifle ranges; of an apparatus for the determination of the areas of the ground that may be seen from any given point; the rapid construction of military mines; the maneuvering valve and disinflating strip for balloons; and in a very exhaustive article Captain Rabozée of the Engineers and Professor at the *Ecole Militaire* discusses the calculation of the stresses and strains etc., in roof trusses.

Of more particular interest to us may be mentioned, *Wireless Telegraphy*, by A. Briffaux, Capitaine Commandant du Génie,—a very thorough discussion of the subject; and *Various forms of Floating Bridges*, by H. Toint, Capitaine Commandant du Génie. With some of the forms here discussed interesting experiments have recently been made in Germany in quickly transporting troops across rivers.

The articles are fully illustrated by plates which are finely reproduced and leave nothing to be desired. H. Jr.

Company Commander's Manual of Army Regulations. Compiled by First Lieutenant William H. Waldron, 29th United States Infantry. Hudson-Kimberly Publishing Company, Kansas City, Mo., 1902. Pp. vii+240, with index. Cloth, $1.00.

All those desiring a handy book of reference of all paragraphs of the Regulations concerning the company's interior administration and economy; reports, returns required, with fac-similes of the forms to be used; books to be kept, etc., will find this book to a great extent convenient and useful. The author has compiled all the paragraphs of the Regulations (1901) that pertain to the company, troop or battery. The digest of the opinions of the judge-advocates general of the army and the Revised Statutes of the United States also have been consulted and pertinent matter therefrom incorporated. The book thus offers one the advantage of having all the details to be observed in the proper administration of a company in compact form, all the paragraphs referring to any one subject being grouped together. We can not say, however, that, in carrying out this idea, the author has adopted a good arrangement or has succeeded in presenting the matter in the best form.

In the first place, the headings used could have been chosen with much better judgment. This would have resulted in much better grouping of the paragraphs and saved needless repetition.

Secondly, under the headings adopted we notice apparently irrelevant paragraphs. For example, under "Company Sick Report Book" we read of "gratuitous issues of clothing will be made, etc". This is only one of many similar cases that we have noticed in the book.

The author, evidently in his desire to have *everything* pertaining to his particular heading or any *word* thereof appear under the same, has introduced much unnecessary repetition of the various paragraphs. We notice even duplication of headings: On page 33, there is "Stationery" and again on page 81 appears "Stationery" with the same matter under each.

Of course, the book is intended for reference, and not to be read through, but a glance through its pages induces bewilderment and confusion due to these faults.

In accordance with modern scientific classification, by throwing *all* the paragraphs relating to any one subject under one judiciously chosen head (with cross-references to other heads if necessary) and then arranging those heads alphabetically, the book could be much more condensed and greatly improved.

Fortunately the book has an excellent index. This feature forms not the least important part of such a work. This index has evidently been made with care and by one familiar with the requirements it should fulfill. The headings are good, are very complete and reduce the labor of reference to a minimum. Reference is given to the particular paragraph and page for the information sought, and the pages of the duplicate paragraphs for any one reference are omitted.

Giving the number of the paragraph as it does, this index could also be conveniently used for the Regulations themselves for all matter pertaining to the company.

Even as it is, this manual will no doubt prove a useful adjunct to the desk of a company commander. H. Jr.

Skirmishing Made Easy: What to do and how to do it, with Questions and Answers. By Major B. Witherby, late Adjutant, 1st King's Own, Yorkshire, L. I. 2nd Edition. London: Gale and Polden, Ltd. 1902, Pp. viii + 47. Six pence.

The first edition of this little book proved so popular, that the author here presents a second edition corrected up to date and in accordance with Infantry Training 1902.

The South African campaign soon showed the necessity of adopting formations and movements which were not in accordance with the principles laid down in the old Infantry Drill.

This pamphlet is the result of the author's experience, and is so clear and simple that it ought to serve as a useful guide to non-commissioned officers and private soldiers in perfecting themselves in this important part of their training.

The value of a sound *preliminary mechanical* training is insisted upon, the various movements of the necessary drill being carefully explained and illustrated by plates, as this disciplining of the mind and body best fits the soldier for the *intellectual* work which follows.

About ten pages of questions and answers concisely covering the subject-matter completes the book. H. Jr.

Rules and Regulations of the National Rifle Association of America and Forty Targets and Scoring Cards. New York: Laflin and Rand Powder Company. 1902. 25 cents.

The Laflin and Rand Powder Company have issued this work which will be appreciated by all riflemen: A book of eighty pages bound in blue cloth, containing the indexed rules of the National Rifle Association, with a blank space left after each rule for any changes; forty targets and scoring sheets which are extremely complete, since the target can be scored on as 1st, 2nd or 3rd class targets, with places for Elevation, W. G., Clock, Light, Flags and Notes; also for Date, Range, Elevation, Time, Ther., Bar., Rifle, Powder, Bullet and Position; an article by Dr. W. G. Hudson on "Notes on the Sight of the U. S. 30-Cal. Magazine Rifle"; points for beginners and an article on loading and re-loading.

This book attracted great attention at Sea Girt at the meeting of the

National Rifle Association of America, and was used by all the celebrated rifle shots. L. R. P. C.

American Rifleman's Encyclopedia. Compiled by A. C. Gould. Published by The Peters Cartridge Co., Cincinnati, Ohio. 1902. Pp. 137. Ten Cents.

This little book forms a collection of words and terms used by riflemen of the United States, with definitions and explanations, and general suggestions for rifle shooting.

A need undoubtedly exists in every calling for a glossary devoted entirely to the terms used therein, many of which will never be seen in any standard dictionary. The author's experience has been that there are many words, terms and expressions used by riflemen which cannot be found in the dictionary and are not understood by many persons,—even by riflemen themselves coming from different localities.

To supply this deficiency, the Peters Cartridge Company have published this Encyclopedia which has been compiled by the well-known editor of our contemporary *Shooting and Fishing*.

The book by no means completely exhausts the subject, but it contains a great many words and terms and much information so often sought by riflemen. In a few cases, for the sake of accuracy, some of the definitions given might be more carefully framed, but taken as a whole, the work is extremely good and full of interesting matter.

Very full scores of International Matches and various record scores with different arms are given; also the rules of the National Rifle Association, the trophies that are to be won, with illustrations, and many other items of interest.

We share with the author the hope that the present work may be considerably enlarged in subsequent editions recording new information developing from increased interest in the subject.

As it is, the work forms a handy and useful book of reference for all sportsmen and riflemen. H. Jr.

Photographic Album of Cambridge University. London and Aldershot: Gale and Polden, Ltd. 1902. One shilling.

This Cambridge album forms a very interesting and attractive collection of photographs of this famous university, the great rival of Oxford.

A short introduction gives a succinct account of the founding of the various colleges, with a few remarks about the University and points of interest in the vicinity. Then follow over thirty views wherein are beautifully depicted the picturesque old buildings, their courts and gateways, park and water scenes, noted objects of interest, and many features of undergraduate life as exemplified in the university sports.

The buildings and their setting are charming, and we can appreciate the loving memories that those who have had the privilege of association with it, must cherish for this famous seat of learning. H. Jr.

EXCHANGE AND BOOK NOTICES.

[Books received will be *reviewed* as space becomes available.]

Le Paysage Militaire. Emploi du croquis panoramique en compagne et dans les reconnaissances. Par le Lieutenant Lefebvre du 4e Regiment d'Infanterie. Paris: Librairie militaire R. Chapelot et Cie. 1901. Pp. 46.

On Outpost Duty: What to do and How to do it. With hints on Reports, Reconnoissance and Scouting. In accordance with Combined Training, 1902. London; Gale and Polden, Ltd. Sixpence.

The Gunner's Catechism. A series of questions and answers in untechnical language for the use of all artillerymen who desire to become either first or second class-gunners. Compiled by Captain Wm. R. Hamilton, Artillery Corps, U. S. A., assisted by Lieut. Paul Stanley Bond, Engineer Corps, U. S. A. New York: John Wiley and Sons. 1902. Pp. x+163. Cloth, $1.00.

Die Armée: Zeitschrift der Kriegswissenschaft fuer Offiziere aller Waffen des Stehenden Heeres und des Beurlaubtenstandes. Muelheim-Ruhr, Germany. Price 9 marks per year.

A new weekly military journal of the above title has just made its appearance, and the first three numbers indicate that it will take its place among the most popular and useful of such periodicals. Its purpose is to furnish good, instructive material for weekly reading at reasonable cost, so as to serve particularly to instruct professionally the younger officers serving with the colors, and those on furlough or in civil life in the intervals between their terms of service.

The articles which have appeared thus far touch some of the leading questions of the day, and are ably presented:

The modern field gun from the stand-point of tactics. Lieut.-Gen'l. v. Janson.

The Boer war and the proposed changes in our tactics.

Are deep or broad formations best for the infantry attack?

The battle of Ligny.

Intervals between skirmishers.

We wish this new venture in the field of military literature all success.

The International Quarterly for September-December, which is to continue the admirable work of The International Monthly, is in its style and list of contents one of the most attractive and important literary publications that has been given to this country. There are 230 pages in this first number, the pages are large, allowing for broad margins, and the typography is clear and pleasing. All of the articles are upon great themes and are written by writers of eminent authority.

The two articles "The Native States of India" by Sir W. Lee-Warner, Secretary of the Political and Secret Departments of the India Office, and the "Egypt of Today" by J. W. Jenks, give an enlightening account of the life and political conditions of these two countries, and their gradual subjection to British administration.

An article of especial interest is "Napoleon", in which Marc Debrit, editor in chief of the *Journal de Geneve*, presents an interesting study on the man in the light of posthumous testimony and recent historical works.

In this number also Mr. Will H. Low explains, in a very original manner the growth of the art interests in France, Germany and England, and contrasts them with our own national art interest and the ways in which it is expressed. He makes an earnest appeal that the material prosperity of this country shall contribute more largely to the encouragement of the American art.

An impartial and well written account of our progress in the Philippines and some interesting and pertinent remarks on the Isthmian Canal are set forth by John B. Bishop; but every essay in this number commends the journal to the interest and support of the reading public.

Cassier's Magazine of illustrated engineering has, amongst others, the following excellent articles in its October number:

The British Fleet. From 1889 to 1902. With ten illustrations of some of the latest British Battleships, and Cruisers and Portraits of Lord Charles Beresford, Sir Charles Dilke and Sir John Colomb. By Archibald S. Hurd.

Costs of Electric Power Transmission. A Practical Application of Principles. By Alton D. Adams.

Progress in the Metallurgy of Iron and Steel. Especially in the Open-hearth Process since 1889. With three illustrations. By Henry W. Howe.

Automobiles for War Service. The Application of Power Traction to Military Purposes. With five illustrations. By Brigadier General J. H. A. Macdonald.

Mining at High Altitudes. Beyond the Timber Line in Colorado, U. S. A. With eleven illustrations. By T. A. Rickard.

Liquid Fuel for Ships. Its Advantages and Disadvantages in War and Mercantile Vessels. By Sir J. Fortescue Flannery.

Current Topics.—A Boat with an Air Propeller, Illustrated.—Marconi Wireless Telegraph Patent Controversies.—Using a Rock Drill as a Power Hammer, Illustrated.—Employers' Rights.—The Rapidity of Electrical Progress. —Municipal Ownership of Public Utilities.—Great Electrical Corporations in Germany.—Financial Difficulties in the German Electrical Industries.—A Peculiar Phenomenon in a Deep Mine Shaft.—Savings from Manufacturing Economies.—Gas from Peat for Steel Making.—A Novel Method of Erecting a Steel Smoke-stack, Illustrated.—Traction Increasers for Locomotives.—The International Iron Trade.

The Niles Tool Co., of Hamilton, Ohio, and New York, U. S. A., send us a handsome and especially finely printed catalogue of ordnance tools, in the pages of which are presented a great many new and special machines peculiarly adapted to the manufacture of ordnance.

This company have placed in operation in many of the largest shops abroad and in this country, and are prepared to furnish, complete equipments for Locomotive, Car, Boiler, Engine and other shops; Government works, etc., for shipbuilding and gun manufacture, etc.

The ordnance machines are strikingly illustrated in this catalogue and in each case a brief description of their design, capability and other particulars is given in English, French and German. In addition there are given some views of the interiors of the important works at home and abroad equipped with their machinery.

The catalogue is a beautiful example of fine press-work.

INDEX TO CURRENT MILITARY LITERATURE.

[For Abbreviation used in Index see first number of each *volume.*]

ARTILLERY MATERIAL.

Ammunition.

Cost of ammunition U. S. navy.—**Naval Inst.**, June.

Wet gun-cotton as the bursting charge for shell.—**Naval Inst.**, June.

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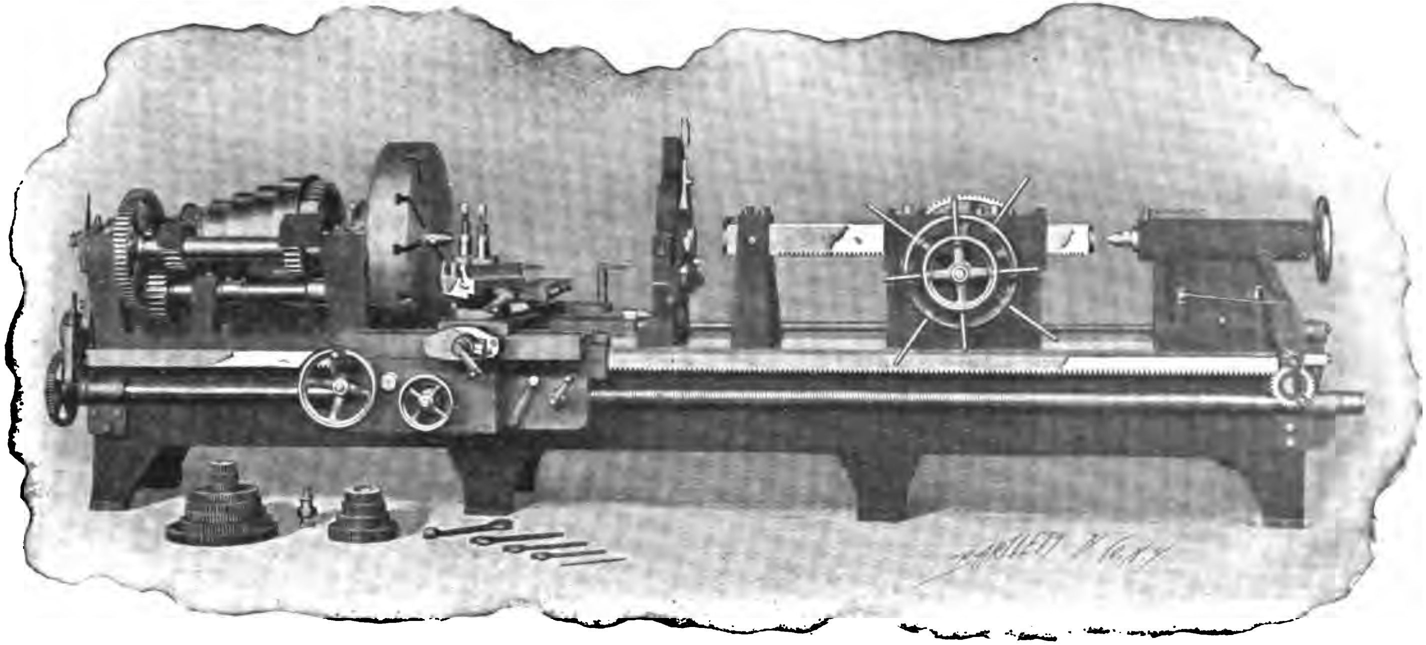

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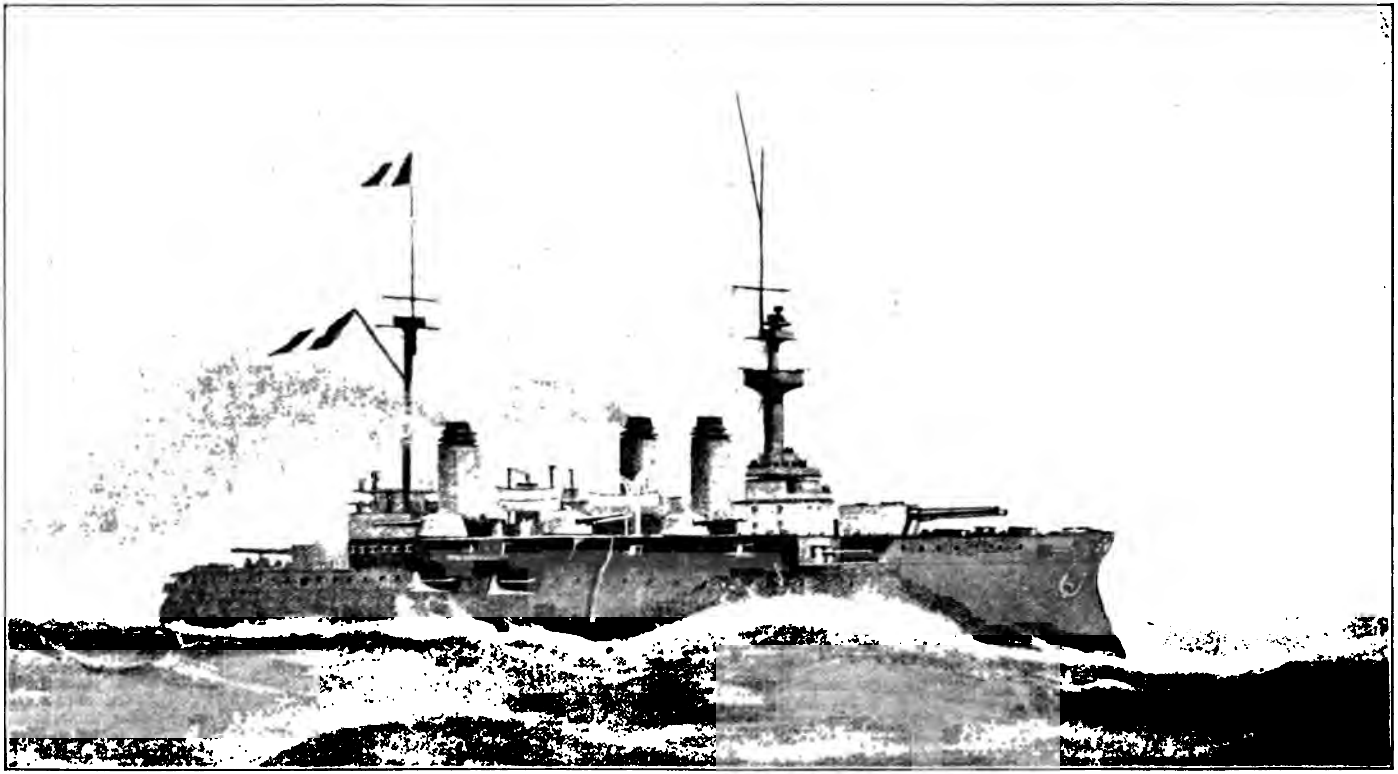

French Battleship "Republique".

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EXTRACTS FROM MINUTES OF THE ARTILLERY BOARD, DATED JULY 15, AND JUNE 20, 1902.[*]

EXTRACT FROM MINUTES OF JULY 15.

The Artillery Board having amended G. O. No. 36, so that it will not be in conflict with the provisions of the proposed order[†] fixing the ammunition allowance and also in some other particulars, desires to submit the following:

The artillery makes no attempt to prescribe what muzzle velocity a powder shall give for a service charge, asking only that it be as high as possible, but, the muzzle velocity being fixed on, the Board submits that the artillery should still be authorized to determine by test whether the muzzle velocity of the powder supplied is as stated.

The Artillery Board is fully aware that no ammunition allowance greater than that provided for by appropriation can be expected, but, at the same time, it submits that the dividing of this allowance into number of rounds should lie wholly with the Chief of Artillery. That is, the amount of money available for artillery practice being stated, it is thought that it should rest wholly with the Chief of Artillery to recommend the kind and number of rounds to be fired. This is properly an artillery matter and should be left entirely in its hands.

In this connection the Board wishes again to submit its views, as embodied in a transcript from its proceedings of June 20, 1902, marked "B", and to add thereto the following additional reasons for objecting to features of the proposed ammunition allowance:

a. The rounds with a muzzle velocity of 1050 f.s. are futile. The ranges are so short, *viz:* 4225 and 3650 yards for the maximum graduations on the carriages of the 10-inch and 12-inch B.L.R., respectively, as to give little or no instruction not attainable with sub-caliber practice at a much less expense.

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[*] Publication authorized.

[†] General Order No. 62, Adjutant General's Office, 1902.

b. The proposed table of allowances gives a *single* round with the service charge of smokeless powder to be fired "not necessarily at a target". The object of this single round is not understood and the money spent for it might well be invested in an additional service round of the same muzzle velocity as the rest of the series.

c. The Artillery Board does not believe in the practice with the 1050 f.s. M. V. for the reasons stated, and would prefer that the amount of money to be invested in rounds for this M. V. be expended for service and sub-caliber rounds in such proportions as may be decided on.

d. Velocities for mortars cannot be fixed for the service, as in table page 8 of the typewritten copy of the proposed order,* because the limits of the zones and the overlap of the same depend on local conditions of channel and harbor. The zones must be determined at each post, for its existing conditions, and requisitions forwarded for charges made up to correspond thereto.

Since a range table for the 8-inch B.L.R., has been calculated for a M. V. of 1950 f.s. and is now in the hands of the artillery troops, (see Artillery Memorandum, Headquarters of the Army, 1898), it is recommended that this muzzle velocity for brown powder for this piece be adopted.

B.

EXTRACT FROM MINUTES OF JUNE 20, 1902.

The Artillery Board is of the opinion that artillery target practice should consist entirely of service and sub-caliber firing, the service practice with the special object of testing, under war conditions, the guns and carriages, the effect of the shock upon telautographs, telephones, ammunition service systems, magazine doors, etc., as well as upon the men necessarily present in the magazines and plotting room. The stable platform of seacoast pieces afford a very favorable opportunity for accurate firing at long ranges before the enemy's guns afloat can be effectively used; valuable practice at these ranges can be obtained only with service charges. Experience in the use of material and its action under service conditions is believed to be of the utmost importance; service practice must be continued from year to year in order to give this experience to the constantly changing personnel.

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* See Sec. VII., General Orders No. 62, c. s., to which this remark applies.

The sub-caliber practice is equally important on account of the opportunity it offers for the proper training of the personnel, especially a greater number of gunners.

Inasmuch as the efficiency of the artillery is measured entirely by its ability to hit, it is believed that as liberal an appropriation as possible should be made for target practice; it should permit as much firing both service and sub-caliber as is now authorized in the navy.

Since the 1050 f.s. velocity would not in any way test the material or illustrate the effects of service charges, above suggested as necessary, and since it would not take the place of sub-caliber practice in the training of gunners because of the much greater cost and the consequent great reduction in number of rounds fired; therefore the Artillery Board does not favor the reduction of the practice velocity to the figure.

Although it did not favor the 1725 f.s. practice velocity, the Board has heretofore accepted it because that velocity was already prescribed for use; the Board now recommends, in accordance with the opinion expressed in the beginning of this report, that artillery target practice consist entirely of service and sub-caliber firing.

THE TACTICS OF FIRE DIRECTION.

By Major G. N. WHISTLER, Artillery Corps.

The Tactics of Sea Coast Artillery is the art of serving sea coast batteries during action.

Such tactics involve the technical considerations which are functions of the technique of the artillery profession, and tactical considerations which are functions of the naval tactics of the enemy, the character of the vessels engaged, and the nature of the field of fire.

"Fire control is the conducting of the tactical operations of any system of defense".

"Fire direction consists in the technical administration of fire, under the orders of the officer exercising fire control".

Such technical operations, however, often involve tactical considerations, and the "technical administration of fire" must depend upon tactical operations.

Therefore the tactics of sea coast artillery may properly be divided into the tactics of fire control and the tactics of fire direction.

The conducting of the tactical operations devolves entirely upon the fire commander, but the battery commander must be governed by the tactics of fire direction in the "technical administration of fire".

The present paper is concerned only with the tactics of fire direction. It will however be necessary to encroach somewhat upon the subject of fire control in order to indicate the manner in which assignments of targets are made by the fire commander.

In this country a great amount of time and ingenuity has been expended in devising technical methods for the application of fire control and direction, the tactical problem having been to a certain extent neglected.

Our Coast Artillery Drill Regulations, which are based upon the English system, clearly outline the fundamental principles of the tactics of sea coast artillery, but the details have not been worked out.

In the English system, "Garrison Artillery Drill, 1895" lays down "that each C. R. A. of a district, will, during time of peace, elaborate in principle and detail, a system for fighting his command".

This idea has been included in our Drill Regulations, where it is provided that each commanding officer of an artillery post will prepare a "complete detailed scheme for meeting the different possible forms and phases of attack".

This defense scheme is to be entered in the Fort Record Book, and provision is made for testing, altering and improving the same.

It is manifest that unless some standard system is adopted for the guidance of fort commanders, this regulation can only lead to the development of as many systems as we have fort commanders, the value of these systems depending upon the tactical knowledge of the commanding officer. Whenever an artillery officer changes station he will have to learn a new system.

Similar considerations have led Captain A. E. Butcher, R. A., to publish his Fighting Book,* intended for the guidance of battery and group commanders, and also probably as a guide to the C. R. A. in elaborating his system.

Captain Butcher's system is in my opinion too complicated, enters too much into detail, and will be found impracticable in time of war. Too many things are required to be remembered and applied during action.

It may be, that with the enormous navy of England, all artillery officers and specialists can be taught to distinguish at a glance the various classes of men-of-war, and to become familiar with the position and thickness of the armor used thereon. In our service it is but occasionally that our officers have the opportunity to see the various classes of naval vessels, and their only means of obtaining information upon the subject is by the tedious study of such books as *All the World's Fighting Ships*, by Fred. T. Jane.

To memorize all of this data is impossible; to apply it during action even with the aid of the A. B. C. system appears to the average officer to be equally impossible.

It is not to be expected that officers will take much interest in the training of men in a system which they firmly believe will be useless in time of war.

A satisfactory working system must be simple, must not require the memorizing of numerous details, nor the use during action of complicated tables, nor in fact of any tables if such can be avoided. The turning over of a single leaf during action to obtain data is undesirable.

All data should be graphically represented on a chart or charts which can be read at a glance. The system should appeal instantly to the common sense of every officer; it should be such that he will be prompted to say, 'this can be carried out in action, this I can teach to my men'. Such a system will be enthusiastically received, and energetically worked up in our daily drills.

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* See *Journal United States Artillery*, September-October, 1902.

It is the object of this paper to suggest such a system. Of course the details of armor, and of class of vessels exist, and cannot be ignored. The problem before us is: How can these details be generalized, be classified, and be presented in so simple a manner that they can be practically used during action? Where memory is necessary a mnemotechnical system must be devised to assist the memory. All statistical data must be graphically represented, so that the information required can be determined at a glance.

CLASSIFICATION OF VESSELS.

To the battery commander, the armament of the vessel assigned to his battery as a target is a matter of no importance. So far as his fire direction is concerned it is a matter of indifference whether his battery is being fired upon by projectiles of 10-inch or 13-inch calibre. His problem is how to attack the vessel in the most effective manner.

The problem which is presented to the fire commander is as follows: To what battery should I assign such a target?

Both of these problems are a function of armor and not of armament.

The attempt therefore to include the character of armament, in classifying vessels, is an unnecessary complication.

In our service as each B. C. will have under his command only guns of one calibre, his tables or charts should not be complicated by data concerning other guns.

In considering the method of classification, the first problem that is presented is how the F. C. should assign targets. The character of the classification must be a function of this determination.

Take for example an English battleship of the *Majestic* class. The vitals are protected by armor only penetrable by 12-inch guns.

The big gun shields are protected by armor penetrable by 10-inch guns.

Bulk-heads and barbettes are penetrable by 8-inch guns.

The entire side armor by 8-inch guns.

Armored deck by 8-inch, 10-inch and 12-inch guns within the deck piercing zone.

Casemates and conning towers by R. F. guns.

To what battery should such a vessel be assigned?

Within the D. P. zone a single shell loaded with explosive "D", or maximite, penetrating the deck and exploding in the vitals of the ship, would destroy the vessel whether fired from an 8-inch, 10-inch or 12-inch gun or mortar. Having passed through the D. P. zone, however, the 12-inch gun is the only weapon except the mortar which can successfully attack the vitals of the ship.

After mature consideration of the conditions of the problem, I would recommend the following rules:

RULE 1.—*Normal Assignment.* As a rule targets will always be assigned to batteries armed with guns of sufficient calibre to penetrate the armor which protects the vitals of the ship.

RULE 2.—*Special Assignments.*—The normal assignment may be departed from in the D. P. zone, or whenever in the judgment of the F. C. it is necessary, which may be due either to special local conditions, or to the paucity of batteries as compared to the size of the fleet.

RULE 3.—Whenever a target is assigned to a less powerful battery than that indicated in Rule 1, it will be called a high order assignment. When assigned to a more powerful battery, it will be called a low order asssigment.

High order assignment indicates that the target is beyond the normal power of the battery to which it is assigned. Low order assignment, that it is below the power of the battery.

Rule 1 immediately suggests a very simple system of classification.

We will assume at present arbitrarily (the reason for which will be explained later on), that 5,000 yards is the maximum range at which any attempt will be made to penetrate armor under any conditions whatever.

Rule for Classification.—Vessels will be classified according to the calibre of the guns to which they would be normally assigned as targets.

CLASS 12.—Vessels the vitals of which can only be successfully attacked by 12-inch B. L. rifles between 1,000 and 5,000 yards range.

Normal assignment to batteries of 12-inch B. L. rifles.

Plate I. shows that this includes all vessels whose vitals are protected by Krupp armor from 11 to 14.5 inches in thickness or its equivalent.

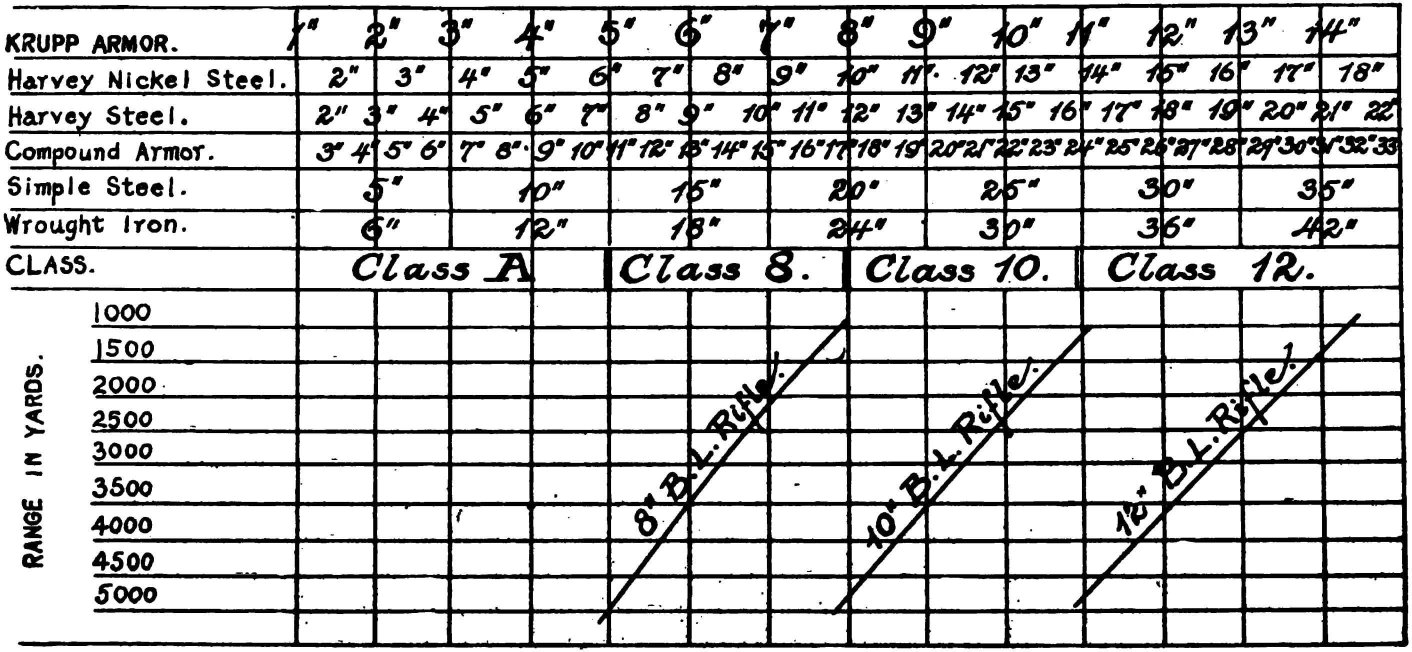

Plate I. Taken from Armor Attack Sheet.

CLASS 10.—Vessels the vitals of which can be successfully attacked by 10-inch B. L. rifles between 1,000 and 5,000 yards range.

Normal assignment to batteries of 10-inch B. L. rifles.

Plate I. shows that this includes all vessels whose vitals are protected by Krupp armor from 8 to 11 inches in thickness, or its equivalent.

CLASS 8.—Vessels the vitals of which can be successfully attacked by 8-inch B. L. rifles between 1,000 and 5,000 yards range.

Normal assignment to batteries of 8-inch B. L. rifles.

Plate I. shows that this includes all vessels whose vitals are protected by Krupp armor from 5 to 8 inches in thickness or its equivalent.

CLASS A.—Armored vessels whose maximum armor is less than the equivalent of Krupp armor of 5 inches thickness.

CLASS O.—Unarmored vessels.

CLASS X.—Unknown vessels, that is vessels which are not contained in the index.

CLASS T.—Torpedo boats and destroyers.

These designations are easily remembered in consequence of the mnemotechnical system used.

Classes 12, 10 and 8 convey instantly to the mind the nature of the classification.

Class "A". Armored vessels not in numbered classes. A, for armor.

Class "O". Zero armor.

Class "T". T, for torpedo.

Class "X". Unknown quantity.

The next question is how is the F. C. to determine the class to which any particular vessel belongs.

The simplest and best method yet devised is the "silhouette index" arranged for the above classification.

Silhouette indices should be made for each navy. Not in book form but on card-board sheets, each navy on a separate sheet.

Silhouette indices of all merchant steamers usually entering the port should be prepared at each post for purposes of instruction. These vessels should be arbitrarily classed, for all of the various classes, and practice should be had in identification and assignment whenever one of these vessels passes in or out during drill.

Whenever an American or foreign man-of-war enters or leaves the harbor, the members of the F. C. and B. C. station details should be required to determine its class by means of the silhouette index.

In addition to this, officers should be required to draw and identify the various silhouettes found in Jane's work.

Of course it would be impossible to have a silhouette for each vessel in such an enormous navy as that of England. In all navies, however, there will always be found a number of vessels which belong to a certain class or type; as the *Majestic* class or the *Admiral* class of England. Sometimes all of the vessels of a class appear alike, generally however they differ in some minor details. Only the silhouette of the class would be entered in the index.

The only objection to the system is that two vessels may appear to the untrained eye to have the same silhouette. This would of course lead to an unintentional high or low order assignment; this cannot be avoided.

Plate II. shows the general form of a silhouette index.

As soon as the F. C. has determined the class of the vessel by the index, the data is instantly sent to the B. C. to whose battery the vessel is assigned as a target. The telautograph symbol would be as follows:

(7/10). Which would be read silhouette No. 7, in Class 10. This not only gives the B. C. the information as to the class of his target, but also assists the observer in identification. He sets his instrument in azimuth and range, then looks at silhouette No. 7, Class 10, in the index, which will greatly assist him in certainly identifying his target.

In identifying targets from a distant F. C. station to a B. C. station, if the vessels of the fleet are any distance apart, there is never any difficulty in identification by azimuth and range alone.

When, however, there are several vessels in the field of view of the telescope, mistakes will be made. In such cases it is wise to send a short description of the vessel. No better or shorter description can be conceived of than the number of the corresponding silhouette.

With the G. F. C. S. system proposed by the Wadsworth board* all of this trouble is obviated.

DETERMINATION OF FIRE ZONES.

The object of establishing fire zones is to eliminate the necessity for committing to memory, or using tables to determine the range at which certain ammunition and character of attack is to be used.

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* *Journal United States Artillery*, May-June, 1902.

The Wadsworth board recommended three (3) zones, to be known as the deck piercing zone (D. P. zone), the intermediate zone (Inter. zone), and the armor piercing zone (A. P. zone). This arrangement I think is very satisfactory.

THE DECK PIERCING ZONE.

The limits of the D. P. zone are easily determined.

The exterior limit of this zone is a function of the power of the gun, difficulties of vision, errors due to abnormal refraction, and instrumental errors of the range finder.

In the absence of extended experiments to determine the maxmum effective range of our guns, we may adopt the following:

For 12-inch and 10-inch B. L. Rifles	12,000 yards.
For 8-inch B. L. Rifles	10,000 yards.
For 6-inch B. L. Rifles	8,000 yards.
For 12-inch B. L. Mortars	12,000 yards.

The interior limit for guns is sufficiently well fixed by the angle of fall of 10°. The interior limit for mortars is about 2,500 yards.

As the 10° angle of fall for all guns is between 6,000 and 7,000 yards, I have, for the sake of uniformity and ease of memory, placed the interior limit at 7,000 yards. From which we obtain the following:

D. P. ZONE.

For 12-inch B. L. Rifles,	from 7,000 yards to 12,000 yards.
For 10-inch B. L. Rifles,	from 7,000 yards to 12,000 yards.
For 8-inch B. L. Rifles,	from 7,000 yards to 10,000 yards.
For 6-inch B. L. Rifles,	from 7,000 yards to 8,000 yards.
For 12-inch B. L. Mortars,	from 2,500 yards to 12,000 yards.

A D.P. zone for the 6-inch guns has been inserted, although the value of this shell for deck piercing purposes is practically zero.

THE INTERMEDIATE ZONE.

The Inter. zone is that portion of the field of fire which lies between the D. P. zone and the A. P. zone.

THE A. P. ZONE.

The width and shape of the A. P. zone, is a function of several conditions and must be determined for each particular battery.

It is a function of :

1st. The penetrating power of the gun.

2nd. The maximum range at which there is any reasonable probability of hitting the side of the ship.

3rd. The inclination of the line of fire to the direction of the approach of the target, which determines the angle of impact.

Perforating power.—It is generally considered that in determining the perforating power of a projectile at any range, the angle of fall must be taken into account. I propose to show that the inclination due to the angle of fall is negligible.

Range 5,000 yds., M, V. 2275 f. s.

12-inch rifle, angle of fall 3° 54′, normal penetration 21.60″, reduced penetration 21.55″.
10-inch " " " " 4° 14′ " " 15.59″ " " 15.55″.
8-inch " " " " 4° 42′ " " 11.06″ " " 11.02″.

The difference between the normal and reduced penetration in steel, due to the angle of fall, does not exceed 0.05″ at this range.

Range 10,000 yards, M. V. 2275 f. s.

12-inch rifle; angle of fall 11° 20′, normal penetration 14.36″, reduced pen. 14.07″, diff. .29″.
10-inch " " " " 13° 18′, " " 10.28″, " " 10.03″, " .25″.
8-inch " " " " 15° 48′, " " 7.19″, " " 6.92″, " .27″.

I have used an M. V. of 2275 f.s. because I had the tables convenient.

It will be noticed that even at 10,000 yards the reduction in penetration due to the angle of fall will be only about ¼ inch. The inclination due to angle of fall is therefore negligible.

Experience has shown that "vertical armor cannot be attacked with advantage when the angle of impact is greater than 30° with the normal". That is, the course of the ship must intersect the "line of fire" between two and four o'clock, or between eight and ten o'clock, according to the direction of the approach.

For the purpose of convenience I have adopted the following nomenclature: A vessel is said to be "broadside-on" to a battery when her course is such that she will intersect the "line of fire" between two and four or eight and ten o'clock. Otherwise she is said to be "head-on". The latter term will be used whether the vessel is approaching or going from the battery. "Dead head-on" indicates that the fire of the battery will rake the ship "fore and aft", not however that the "line of fire" is absolutely coincident with the axis of the ship, but so that it is impossible to strike the side.

The normal exterior limit of the A. P. zone is a curved line so situated, that any vessel crossing the same, in the direction, and with the intent to "run by", will be "broadside-on" to the battery. Of course this can only be determined for the attempt to "run by" assuming that a vessel will take the shortest course. A vessel, wherever she may be situated, can always turn "head-on" to the battery if her commander is willing to lose time by such a maneuver.

The geometric method of determining this curve will be described later on.

The second proposition may be stated as follows. Beyond what range would it be useless to attempt to pierce the vitals of a vessel "broadside-on"?

It is manifest that the problem is a function of the probability of hitting the protecting armor, and not of the penetrating power of the gun. We can lay our guns within about plus or minus one half minute of the desired elevation, but our minimum variation is one minute.

It is therefore manifest that we cannot be sure of laying our gun to strike the "free-board" at any range where the "free-board" subtends an angle of less than three (3) minutes. Taking the average "free-board" as five yards (15 feet) the limiting range would be 5,700 yards.

To be on the safe side I would recommend that 5,000 yards be fixed as the range beyond which no deliberate attempt should be made to penetrate the vitals of a ship "broadside-on."

GEOMETRIC DETERMINATION OF THE EXTERIOR LIMIT OF THE A. P. ZONE.

Plate III. shows the geometric principles involved. Let B represent the center of the battery. A-C the course of the vessel. From B drop the perpendicular B-D upon A-C. Lay off B-P so as to make an angle of 30° with B-D. Then if B-P is equal to or less than 5,000 yards, P is one of the points of the curve required, which marks the exterior limit of the A. P. zone.

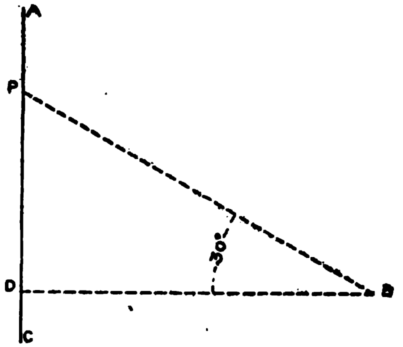

PLATE III. GEOMETRIC DETERMINATION OF EXTERIOR LIMIT A. P. ZONE.

If B-P is greater than 5,000 yards then the exterior limit intersects the line A-C at 5,000 yards from B.

Plate IV. shows a general case of open harbor without channels. Let B represent the center of the battery. H-H¹ the entrance to the harbor. B-E and B-E¹ the extreme limits of fire of the battery in either direction.

Now a vessel starting from any point at sea, attempting to "run by" through H-H¹ on the shortest line, must intersect B-E somewhere between F and F¹.

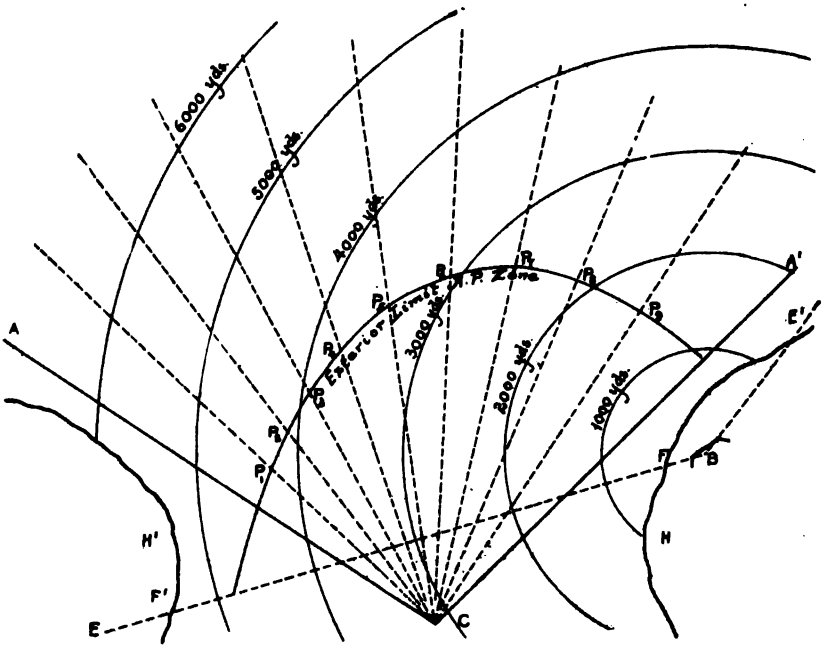

PLATE IV. GEOMETRIC DETERMINATION OF EXTERIOR LIMIT A. P. ZONE, IN OPEN SEAWAY.

Let A-C represent the extreme course on the left, the water between this line and the shore being too shallow for the ships. Let A′-C represent the extreme course on the right. These two lines must intersect at some point as C. As in the case of the entrance of such a harbor, both sides will undoubtedly be fortified, and vessels running by will undoubtedly pass mid-way between the two sides, the error will therefore not be material if we consider that all vessels will move on a straight line passing through C. The point C may be placed arbitrarily to meet known conditions.

In the angle A C A′, draw through C the radii shown by the dotted lines at equicrescent angles, say about 10°.

Now considering each of these 10° radii as a course of a vessel, determine the points P_1, P_2, P_3. etc., as shown in *Plate III*.

A curve passed through these points will be the extreme limit of the A. P. zone unless any part of the curve is a greater distance from B than 5,000 yards. In such a case, in that particular locality, the 5,000 yard range circle will be the boundary of the zone.

RANGE AT WHICH "FIRE AT WILL" SHOULD BEGIN.

Within the A. P. zone there is another important circle to establish. That is the range at which "fire at will" should begin.

This circle is the range at which corrections for atmospheric conditions may be ignored. The Wadsworth board recommend 2,500 yards; this is based upon the following considerations:

For a 12-inch B.L. Rifle. Service charge. Range 2500 yards.

The allowance for a 1% change in weight of air is 2.3 yards.

The allowance for a 10 mile head or rear wind effect is 3 yards.

The allowance for drift is 0°.03.

The allowance for 10 mile deviating wind effect is 0°.03.

Assume an atmospheric condition of + 15% and + 50 mile per hour head wind. The correction for these conditions would be + 50 yards. The slope of fall at this range is about 1 on 40. If now we ignore this correction the vertical variation will be 1.25 yards or less than four feet. As this would not take the shot off the side of the ship, it is manifest that even under these extreme conditions, which will never occur in practice, corrections for range can be ignored.

Now consider a — 50 mile per hour deviating wind effect.

The correction for wind and drift would be 0°.18 which at this range would deviate the projectile 4.5 yards. If the gun is fired so as to strike the vessel amidships the vitals would surely be reached.

Drift at this range amounts to 1.50 yards. Therefore even under these extreme conditions the corrections for deviation may be ignored. The same conditions hold for the 8-inch and 10-inch guns.

Let us now consider speed of vessel. The maximum speed of the "run by" will not exceed 20 miles per hour except for torpedo boats.

Travel during time of flight at 2500 yards range:

For 12-inch guns = 33 yards = 99 feet.
For 10-inch guns = 35 yards = 105 feet.
For 8-inch guns = 37 yards = 111 feet.

If the shot is fired at the bow of the vessel without any allowance being made, it will strike the side armor and penetrate the vitals.

With untrained or partially trained gunners we may therefore within this range adopt the following:

RULE.—Make no allowances and fire at the bow.

The determination of a more accurate method of work is discussed under the head "Fire at will".

Plate V. gives a sample of a B.C. Battle Chart based upon the foregoing system.

BATTLE TACTICS.

General rules which govern the action of battery commanders.

1.—No B.C. may select his own target, but must direct his fire on that indicated to him by the fire commander.

2.—No B.C. may open fire until permitted to do so by the F.C. except under exceptional circumstances, when he may act upon his own responsibility, reporting his reasons for so doing to the F.C.

3.—Commands to commence firing will be given as follows:

Commence firing at maximum range, (F. M. R.). This requires the firing to begin as soon as the target is within the range of the guns of the battery.

Commence firing at a given range, (F 8000.) This requires the firing to begin at a particular range as 8000 yards.

Commence firing, (F). Firing to begin at once.

The letters and figures in brackets are telautograph code signals.

4.—Under normal assignment or a high or low order assignment, the B.C. will make his attack as prescribed under these heads.

The attack on a vessel indicated as Class X will always be made as though the assignment was normal.

5.—B.C's. will determine the projectile to be used, in accordance with this system, as indicated in the Battle Chart.

6.—The attack on vessels of Classes A and O by high-powered guns will always be made with shell at all ranges.

ATTACK IN THE D. P. ZONE.

The attack is the same for normal, high or low order assignment.

It should always be remembered, that the importance of this attack not only depends upon hitting the vessel, and thus putting the ship out of action, but also upon the demoralization produced by shells loaded with high explosives falling in close proximity to the vessel.

The effect of shells falling close about the ship at these extreme ranges, even though hits are not made, will impress the enemy with the accuracy of the fire, will render them extremely cautious, and may possibly produce the impression that it will be impossible to attempt to "run by" or attack at closer range.

The discovery that high explosives of such enormous power can be fired from high-powered guns, and the shells be exploded within the vitals of the ship, has made the attack in the D.P. zone one of the most important features of harbor defense.

Extreme accuracy of fire should be the key note of the attack in the D.P. zone. Rapidity of fire should be sacrificed to accuracy. By this it is not meant that time is to be wasted, nor a shot held unnecessarily, but everything should be done to insure accuracy.

Whenever the combination system is installed (and it should be installed at every station), the horizontal base method should always be used within the D.P. zone, in order to insure accuracy in tracking, and in locating the predicted and set-back points, as well as to avoid the errors due to the extreme conditions of abnormal refraction at these ranges.

Certain facts must always be kept in mind. The errors due to deviation observed with our guns are slight; there is generally no difficulty in doing good line-work at any range. There should be no difficulty with reasonable care in locating and relocating, in keeping on the target in the D.P. zone, so far as deviation is concerned, whether the vessel is "head or broadside on".

The great trouble is variation in range, due to errors in range determination, variation in the powder, and inability to determine the atmospheric conditions over the entire range, and to make corrections therefor.

Error in range determination can be reduced to the minimum by the use of the horizontal method, and by great care in platting, locating and relocating.

Atmospheric conditions and the corrections to be made therefor can best be made by firing a trial shot before the enemy enters the field of fire. Batteries should be furnished with cast iron projectiles for this purpose.

Powder variations and sudden changes in wind or other atmospheric conditions are beyond our control except to a limited extent. Every B.C. should endeavor to observe the fall of the projectiles from his own battery and correct thereby. This may not generally be possible, as he cannot distinguish his own projectiles, but every effort should be made to do so. In stations where the B.C. is furnished with a D.P.F. in addition to the Type "A" as recommended by the Wadsworth board, which is decidedly preferable to the instrument for observation of fire provided by the Drill Regulations, the following plan is suggested :

The B.C. when he sets his instrument on the set-back point will note the time of flight for the range, a table of times of flight being conveniently posted near his instrument. As soon as the guns are fired he follows the target, counting seconds. The shots falling near the target at the expiration of the time of flight, will probably be those from his own battery.

A vessel "head on" presents a larger target than one "broadside on" so far as range variation is concerned. If the predicted point has been correctly located, and the vessel maintains its course and speed, the probability of making a hit "head on" should be greater than when "broadside on". In crossing the D.P. zone under fire the vessel will probably maintain a straight course and constant speed in order to get through as soon as possible.

Considering range determination alone, the probability of making a hit is the other way. When "broadside on" the range remains fairly constant, whereas when "head on" the range changes rapidly.

When "head on" the target is crossing the zone on the radius, the shortest course. Therefore it will be possible to get in a greater number of shot when the target is "broadside on" than would be possible when it is "head on".

The shortest distance across the zone is of course 5,000 yards. The average speed of the targets may be taken at about 16 miles per hour. At this rate the zone could be crossed in about 10 minutes. The average time of crossing may be placed at from 12 to 16 minutes,

With four (4) minute firing interval for the 12-inch guns and three (3) minutes for the 10-inch guns, it will usually be possible to get in from three to four salvos from the 12-inch guns, and possibly five from the 10-inch guns. The 8-inch guns cover only half of the zone.

While of course the guns can be fired at a faster rate, it cannot be done with sufficient certainty of accurate work.

It is not a question of loading the gun, but of accurate determination of the range, and the location and relocation of the predicted point.

In my opinion no more rapid rate is admissible within the D.P. zone.

The objection to a more rapid rate at these ranges is the fact that the attempt to hasten the work tends to make the platters and computors, accept inaccurate plattings and computations as "close enough".

It destroys the deliberation which is always essential to great accuracy. From three to four minutes' interval gives ample time for deliberation, and the most accurate work possible. In this connection it must be remembered that the danger space in this zone is very small.

Every B.C. should feel that his reputation as such depends upon the accuracy of his work in the D.P. zone.

Unstability of the gun platform aboard ship renders it exceedingly improbable that any attempt will be made by the enemy to reply to the fire of the batteries from within the D.P. zone. If they should, the fire would be wild, and no danger is to be expected to the batteries except from an accidental shot.

This leads to two conclusions:

First, that the deliberate work in the B.C. station or at the guns will not be interfered with by the fire of the enemy.

Second, that the enemy will not attempt to maneuver within this zone for the purpose of making an attack, and that the direction of travel will be confined to that necessary to pass through the zone.

NIGHT ATTACK.

The power of the present search lights, as claimed by the manufacturers, is about as follows:

A 24-inch light will illuminate a vessel at 5,000 yards.
A 30-inch " " " " " " 6,000 "
A 36-inch " " " " " " 7,000 "

Under certain conditions this can be exceeded by from 10% to 15% of the range. It is manifest, however, that unless more powerful lights are obtained, it will be impossible at night to attack vessels within the D.P. zone. Consequently the D.P. attack will necessarily be confined to action during day light.

THE ATTACK IN THE INTERMEDIATE ZONE.

The naval attack upon the forts will begin within this zone, and the character of the operations will depend upon the naval tactics adopted by the enemy.

Whatever may be the character of the naval operations, or the tactical operations adopted by the F.C., there will be but three conditions to be considered in the tactics of fire direction.

The target assigned to any battery will either run through the zone, maneuver on a closed curve entirely within the zone, or maneuver on a closed curve partly within and partly without the zone.

The operations of the batteries will be carried on under a heavy fire from the larger guns of the ships. There will be but little danger to the F.C. or B.C. stations except from an accidental shot. The range is too great for the machine guns of the enemy to be effective.

Penetration of vitals through the protected deck is only possible with mortars.

Penetration through the armor to the vitals is not possible, except under particular conditions to be considered hereafter.

The normal point of attack in this zone under normal assignment is therefore: The superstructure, gun-shields, conning towers and unarmored portions of the ship.

Should the vessel come "broadside on" within 5,000 yards, an attempt should be made to penetrate to the vitals through the armor. Under normal assignment use A.P. shot for this purpose.

Under low order assignment use A.P. shell, especially if the difference in class is greater than one order. The reason for this is to take advantage of the greater amount of explosive in the shell.

If an A.P. shell strikes the vessel and explodes outside, change immediately to A.P. shot.

Under high order assignment no attempt should be made to penetrate the armor within the Inter. zone.

If the target is "running through" the zone, no opportunity will be given to fire at the broadside, unless some accident brings the vessel "broadside on".

If the target is maneuvering within the zone, such opportunity may often occur, and should always be taken advantage of. If the guns are loaded with A.P. shell when the target comes "broadside on" fire directly at the broadside, note the effect and change on the next round to shot if deemed necessary.

The rapidity of fire may be considerably increased within this zone. Three minutes' firing interval is the slowest speed admissible, accuracy should not however be sacrificed to rapidity.

If the target is running through the zone with the intention of "running by", it will probably maintain a constant course and speed during the passage. In such case tracking of the target after the first speed determination may be omitted. The course may be laid out as a straight line or a curve according to the nature of the harbor, and predicted points be taken at intervals, depending upon the known time required to load and accurately lay the guns.

In this connection it should be remembered that the tactics during this epoch of the action will depend materially upon the nature of the field of fire. Consider New York Harbor. For the batteries at Fort Hancock, the Inter. zone will be in an open sea-way in which the enemy can maneuver at will. Whereas for Forts Hamilton and Wadsworth vessels in this zone must confine themselves to certain limits or go aground.

When the target is maneuvering within the zone it may be considered as a certainty that everything will be done to disconcert the fire of the batteries. Targets will not move in straight lines nor at uniform speed. The ingenuity of the B.C. will be taxed to the uttermost to meet these conditions. Probably the most efficacious method of fire direction will be to delay your prediction until the guns are loaded, then predict from two observations 20″ interval, with 40″ prediction interval. This should give a firing interval of about two minutes for 10-inch guns, and will allow the target but 40″ to vary her course. The firing interval would of course be somewhat greater for 12-inch guns but should not exceed three (3) minutes.

Should the B.C. station be furnished with two instruments, continuous tracking could be done with the Type "A" and the firing be controlled by the Type "B".

Within this zone except at extremely low sites the depression method can always be used. Even at low sites the D.P.F. can be used with great accuracy by the following plan: Determine the range of the target by the horizontal method, set the D.P.F. for that range, waterline the target by the elevating screw, afterward use the D.P.F. to obtain more rapid work. This however pertains more properly to the technical rather than to the tactical work of fire direction.

Beyond 5,000 yards it will generally be impracticable to select the particular part of the target to be attacked; and even within 5,000 yards within this zone, the probability of hitting the desired point will be greatly a matter of chance. The following method should however be used. Track, predict and determine the set-back point point from the bow of the vessel. Fire as the portion of the target it is desired to attack passes the set-back point. If correct platting and relocation has been done, the direction will be correct, but whether the superstructure or the hull is struck, or a miss is made, will depend upon the range of the projectile, and whether the target has passed the predicted azimuth at the predicted range. Within 5,000 yards, however, very good work ought to be done.

The slope of fall at 5,000 yards for 8", 10" and 12" guns will be about 1 on 15. Therefore the danger space of a vessel of the size of the standard target, when broadside on, is 136 yards, head on 232 yards.

For the 10" B.L. rifle 136 yards corresponds to a change in velocity of 40 f.s. and 232 yards of about 70 f.s. ; the former distance corresponds to an error of elevation of about 6', and the latter of about 11'.

It is hardly probable that such a variation in powder from shot to shot, or such an error in laying will ever occur. It would be very poor prediction in which a vessel would not pass within 100 yards of the predicted point, at a range of less than 5,000 yards.

It is therefore very improbable that a miss will be made, but the chance that the side armor will be hit, or the superstructure as may be desired, is about one in two. I consider that the probability of hitting a vessel of standard target size between 4,000 and 5,000 yards as about 80 per cent. under the excitement of action. This would make the probability of hitting either the hull or superstructure, at will, about 40 per cent.

Within 5,000 yards the effort should be made to direct the fire at that portion of the target where it may be expected to do the greatest damage. Try to destroy the conning tower, or the steering gear or to put the guns out of action. If she comes broadside-on try for the vitals.

Should a target, due to damage to her machinery either from shot or by accident, destruction of steering gear, running aground or for any other cause, be brought to a stand still, instant advantage should be taken of the same to render the ship *hors de combat.* The firing interval should be decreased as much as is consistent with accurate work, and fire should be continued as at a fixed target, until she strikes her colors, is destroyed or gets underway again.

Should a target strike her colors firing must instantly cease and the fact be reported to the fire commander. Should the fire commander fail to assign another target to the battery, the battery commander will open at once upon the leading vessel of his own class, and continue to fire thereat, until another target is assigned or he is ordered to cease firing. This rule is general after an action has begun, when for any reason the battery has no target assigned, unless the order for him to cease firing has been given.

The principle is that a battery commander will not commence firing until ordered, nor select his own target. But having once been ordered to begin the action at a certain target, he will not allow his battery to remain idle, but continue firing on something until ordered to cease; always, of course, reporting the fact to the fire commander.

A similar rule applies when the high-powered guns are ordered to attack a fleet of torpedo boats attempting to destroy the mine field. High-powered guns do not open upon such boats unless ordered, but having been ordered to commence firing they endeavor to destroy the entire fleet, without further orders from the fire commander unless, of course, they are ordered to cease firing.

Under normal assignment the battery commander will warn the battery to be ready to change to A. P. shot as the target approaches the A. P. Zone, and will change as she crosses the line.

Under high order assignment such change should not be made as it is impossible to attack the vitals with the guns of the battery with any kind of ammunition.

Under low order assignment with difference of but one order, change to A. P. shot. If the difference be greater than one order, continue with A. P. shell as they will surely penetrate the armor and the explosive effect will be much greater.

THE ATTACK IN THE A. P. ZONE.

In the present paper it is assumed that the entrance is not mined, that the mines have been destroyed, or that the enemy proposes to take all chances and run by at speed. The idea is that the rules which govern the tactics of fire direction are independent of any harbor obstructions. The battery must always be fought as though the target assigned to it had a clear way to run by.

Mine field defense is a function of the tactics of fire control, and must not even be considered in the tactics of fire direction, except where a battery is assigned to the defense of the mine field.

In the A.P. zone the fire of the enemy will be at its maximum, from large guns, small guns and machine guns. If the attack is carried on in a masterly manner, the F.C. and B.C. stations will probably be destroyed. They will, however, be used as long as tenable, or until the target comes within the range of "fire at will".

The enemy will not enter this zone knowingly except for the purpose of running by, which they will do at full speed and in a straight course.

Tracking will cease. A straight line will be marked on the platting board from the last prediction, as the course of the vessel, and predictions will be made thereon; the set-back will be made from the last determined speed, and the firing interval will be reduced to the minimum. Probably not more than two salvos can be fired by prediction before the vessel enters the range of "fire at will". The last determined speed of vessel must be sent to the battery for use by the gunners during the "fire at will".

THE FIRE AT WILL.

The command of the gun passes into the hands of the gun commander. Firing is done entirely by Case II. and the most *rapid fire possible* is used. The best method of doing this is a technical and not a tactical problem.

The method adopted must be one that will ensure the hitting of the hull or superstructure at will. The probability of hitting the vessel within this zone is 100%. The technical proposition is how to insure penetrating the vitals.

Always endeavor to penetrate the vitals with A.P. shot or shell except in the case of high order assignment, when the attack must be made at the superstructure.

A satisfactory technical method for this work cannot be said to have been devised as yet. A very good method is described in the report of the Wadsworth board. The ideal system is however the automatic sight. The errors due to the automatic system are so great that it can never be used at long range, or at any range where the abnormal refraction is liable to be great. Our emplacements have an average height even at the lowest sites of 32 feet. With such height very accurate work ought to be obtainable with the automatic sight within 2500 yards. The semi-automatic sight proposed in the latest models of disappearing carriage for the 12-inch guns may give good results.

A satisfactory automatic system for short range work, taken in connection with the use of maximite or explosive "D" together with the Dunn delay fuze, will blot the "run by" out of the tactical books of seacoast artillery.

Thus far I have considered the entrance into this zone for the purpose of the "run by". It is, however, possible that a vessel maneuvering in the Inter. zone may unintentionally enter the A.P. zone. If so, instantly change to A.P. shot and endeavor to reach the vitals.

SALVO POINTS.

In certain interior harbors and at the entrance of any harbor, there may be positions of greater or less area through which a fleet must pass. These may be designated as salvo points, and be lettered as salvo points A. B. C., etc. The data for covering these areas should be carefully determined, and be posted in each emplacement for that particular gun. The exact data for the set-back for each of such points will be posted in each B.C. station. As the fleet approaches one of these points, such as salvo point "G", the F. C. sends the order as follows: **(S. P. G. 2.)** which reads, "All guns lay on salvo point 'G' and the B.C. will fire as the 2nd vessel passes the set-back point".

Thus a crushing salvo from all of the guns bearing upon the point will be delivered simultaneously upon the designated target.

As soon as the salvo has been delivered, the several B.C. will return to the attack of their own targets unless ordered to the contrary.

MORTARS.

The tactics of the fire direction of a mortar battery differs materially from that of batteries of guns.

In this paper I will consider a mortar battery as consisting of four (4) pits, 16 mortars in all. For smaller batteries the same principles will hold.

All mortar attack is deck attack, and the entire field of fire becomes a deck piercing zone. It extends from a range of 2500 yards to 12,000 yards. From 2500 yards to 5,000 yards is called the interior zone, and from 5,000 yards outward is called the exterior zone.

The ammunition used with 12″ B.L. mortars is the following:

Cast iron shells	800 lbs.,	used for target practice, and for ranging.
" " "	1000 "	" " " " " " "
A. P. shell	800 lbs.,	filled with high explosive. Service shell.
Torpedo shell	800 "	" " " " " "
A. P. shell	1000 "	" " " " " "
Torpedo shell	1000 "	" " " " " "

In the exterior zone, always use 800 lb. A.P. shell or torpedo shell.
In the interior zone, " " 1000 " " " " " "

Mortar fire will be used to cover an anchorage; to reach vessels which cannot be reached by guns; to cover particular areas through which the fleet must pass; to cover a channel which cannot be mined; to cover salvo points; to maintain a rain of projectiles upon the leading vessels of the fleet; occasionally to attack particular vessels.

The character of fire may be divided into three orders of fire.

1st. Fire by battery: In this the entire 16 mortars are fired simultaneously.

2nd. Fire by single pit: In this one or more pits may be directed upon a certain area, or the four pits may be directed each upon a different area.

3rd. Fire by pit: This is a special method of fire, in which the four pits fire alternately at fixed intervals.

There should be no difficulty in firing mortars at two minute intervals. If then the four (4) pits fire alternately at ½ minute interval, a stream of projectiles will be kept in the air and the firing interval of each pit will be two minutes.

Such a stream of shells loaded with high explosive, pouring into an area through which the fleet must pass, or falling in rapid succession about the leading vessels, must certainly be extremely effective and terribly demoralizing. Most effective work ought to be possible with mortars against a fleet maneuvering in the Inter. zone where deck attack is impossible with guns.

The F.C. determines not only the order but the rate of fire. We may thus have:

Fire by battery single salvo.

Fire by battery at 2, 3 or 4 minutes' interval.

Fire by pit at 2, 3 or 4 minutes' interval, each pit being fired at ¼ the designated interval.

Single pit fire at any designated interval.

Fire by battery is used to cover salvo points.

Fire by pit is used to cover particular areas through which a fleet must pass; to cover a channel which cannot be mined; to maintain a stream of projectiles upon the leading vessels of the fleet.

Single pit fire is used to cover anchorages; to attack vessels which cannot be reached by guns.

The value of fire by pit should be specially noted. Except at the short ranges, the time of flight of a mortar shell will generally exceed 30 seconds. Therefore a continuous fire by pit, 2 minute interval, will maintain eight (8) shells in the air at the same time.

So far as I know no rule has been established to determine when to use the A.P. shell and when the torpedo shell. In the case of a special assignment to the attack of a vessel, the rule would be simple.

Use A.P. shell for Class 10 and 12 and torpedo shell for all other Classes. The assignment of special targets to mortar batteries will only occur occasionally, and may be regarded as the exception and not the rule.

Major Sedgwick Pratt, Artillery Corps, has suggested a scheme which appears to me to be admirable and practically to solve the problem.

His plan is as follows:

One-half of the pits (pits A and C) to be furnished with say ⅔ A.P. shell and ⅓ torpedo shell.

Pits B and D to be furnished with ⅔ torpedo shells and ⅓ A.P. shell.

Pits A and C always use A.P shell unless directed to the contrary.

Pits B and D always use torpedo shell unless directed to contrary.

With this system, in the fire by battery or fire by pit, half the shells fired would be A.P. shell and half torpedo shell.

In firing by single pit, the B.C. would open with the pit using the particular projectile he desires to employ.

Each pit has a supply of the opposite kind of ammunition to use if so directed. Should the action continue so long that the total supply was exhausted, still the equal division of the two kinds of shell would continue to the end.

NIGHT ATTACK.

During a night attack the targets for all batteries must be assigned by the F.C. light, and it may not be possible to determine the exact classification of the target, in which case they will always be assigned as Class X. Of course with our present lights no attack can be made in the D.P. zone.

With an efficient illuminating light, and the cross-hairs of the position finders properly illuminated, tracking, predicting, and firing on the set-back point can be done as accurately at night as during the day.

The principles laid down for day work apply equally well during the night.

No technical method for night work has yet been officially approved except for trial. See Report of Fire Control at Fort Wadsworth*. A similar method has been described in the report of the Wadsworth board. This method has been thoroughly tested and is entirely practical. Its use is recommended pending an official adoption of a system.

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* Report on Fire Control and Fire Direction, employed at Fort Wadsworth, New York Harbor, by Captain G. N. Whistler, Artillery Corps, U. S. A. Published by direction of the Secretary of War, Government Printing Office. 1901, (pink pamphlet).

RAPID FIRE GUNS.

Six-inch R.F. guns mounted on disappearing carriages should be classed as high-powered guns and be fought in the same manner. Such batteries should be equipped with a B.C. station. The proper targets to be assigned to such batteries would be vessels of Class A.

Six-inch guns mounted on pedestal mounts should be classed as R.F. guns.

R.F. guns may be divided into three classes.

CLASS 1.—6-inch, 5-inch, 4.7-inch and 4-inch R.F. guns, fixed mounts.

CLASS 2.—15-pounders and 6-pounders R.F. guns, fixed mounts.

CLASS 3.—15-pounders and 6-pounders R.F. guns, movable armament.

All R.F. guns on fixed mounts when the height of the site is sufficient should be fitted with automatic sights.

R.F. guns Class 1.—Are used against vessels of Class A and O also T, which they are competent to render *hors de combat.* They will also be used against larger vessels to fire into the mouths of heavy gun shields, to destroy the conning towers, and the steering gear, and against unarmored parts.

R.F. guns Class 2.—Are used to protect the mine field, to keep down the fire from the tops, prevent landings, to fire at the base of the masts so as to destroy ammunition hoists, and they can also be used against vessels of Class O and T.

R.F. guns Class 3.—Are used to protect the mine field, and to prevent landings. Their chief feature is their mobility.

The extended distribution of these guns, and the varied character of the work for which they are suited renders the problem of fire control of this armament extremely difficult of solution. It must be admitted that they will be to a great extent semi-independent, and in certain epochs of the attack absolutely free lances.

R.F. guns will of course will not be used in the attack in the D.P. zone, and will not open on the vessels in the Inter. zone unless ordered to do so.

Not being furnished with position finders nor graduated azimuth circles, assignment to particular targets is extremely difficult. The technical method of making such assignments has not as yet been solved, and its solution must not involve position-finders, B.C. stations or base lines.

Until some method is devised R.F. guns will be assigned to the leading, second, third or other ship, by any ready method of designation. The character of the attack must be left to the immediate commander.

As soon, however, as the first vessel enters the A.P. zone, every R.F. gun that can bear opens upon it. All R.F. guns attack according to their class. As more vessels enter the zone, unless orders are received from the F.C. assigning targets, the immediate commanders use their own judgment as to the distribution of fire. The F.C. should elaborate a scheme of instruction for his R.F. commanders to be used during action, as it will not be possible to give them the same attention during the action which he can give to the high-powered guns. These instructions will differ for different localities and conditions.

R.F. guns may be assigned to certain sectors of fire with directions to attack vessels in that sector, to attack the leading ship, or one in the next sector.

If R.F. guns have no illuminating lights of their own, they will, during the night attack, be assigned to one of the illuminating lights of some high-powered battery, with orders to attack the vessel illuminated by the light to which they are assigned.

R.F. guns specially assigned to the protection of the mine field open upon any Class T or O vessel entering the field without waiting for orders. Class 1, R.F. guns, open upon any vessel under similar conditions.

Any R.F. commander noticing an attempt to land will open instantly on the boats without waiting for orders, unless assigned to a special duty with orders not to engage anything else.

These rules are of course general, and in fact no special rules can be established, as they must depend to a great extent upon local conditions.

CONCLUSION.

I do not wish to be considered as setting myself up as an authority upon this subject, as my views are based upon theory and not upon experience.

This paper is the result of much thought and many years of study, and is offered merely as a suggestion, to be used as a guide, until such time as an authorized system shall have been prescribed by the Chief of Artillery. It is earnestly requested that the subject may be discussed and the system criticized. Any suggestion will be gladly received, either personally or through the service journals, that will lead to a satisfactory solution of the many problems of the Tactics of Fire Direction.

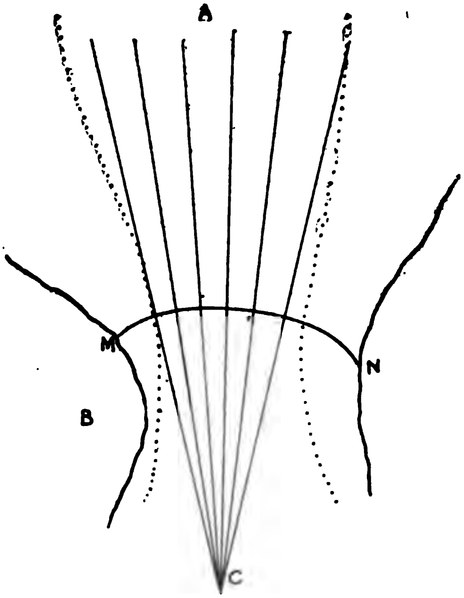

PLATE A.

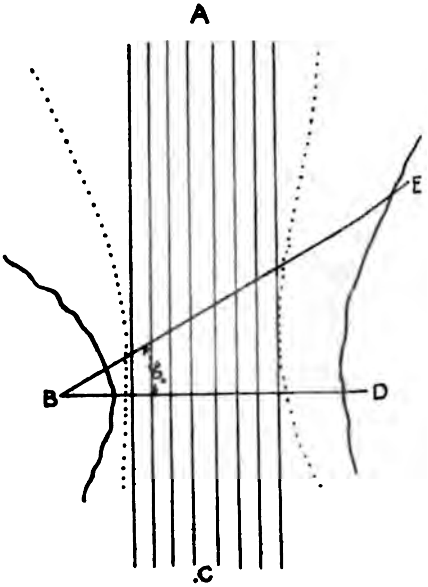

PLATE B.

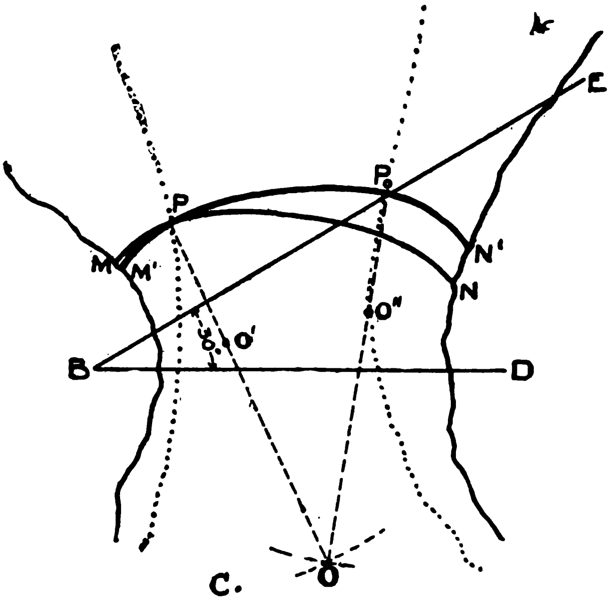

PLATE C.

AMPLIFIED METHOD OF DETERMINING THE EXTERIOR LIMIT OF THE A. P. ZONE.

After having constructed some 23 battle charts and having made a tactical study of several harbors, I have concluded that the method described in my paper will not suffice for all conditions, and I therefore append the additional method which I used in constructing the charts.

The method is clearly shown in the plates A, B and C.

B represents the position of the battery in each plate.

Plate A shows what I call a converging entrance, that is, the vessels enter on one of the converging lines from A to C. The limiting curve MN of the A.P. zone is constructed as already described.

Plate B shows what I call a parallel entrance, that is, the vessels may enter on one of the parallel lines. It is manifest that if we draw the line BD perpendicular to the parallel lines, and then lay off BE making an angle of 30° with BD, BE would be the limit of the zone for such an entrance.

Plate C shows the two limits MN and BE and it is manifest that neither cover every possible condition. Let the dotted lines represent the limit of the water area navigable by battleships. It is manifest that under certain conditions a vessel at P could be penetrated, but this point is not covered by the limit BE. In the same manner a vessel at P_0 could be penetrated under certain conditions, but this point is not covered by the limit MN.

It is manifest that the true limit of the zone must be a curve similar to MN which passes through the points P and P_0. Such a curve can be constructed by points, by changing the position of C; the process however is tedious. I have adopted the following method of construction.

With a radius equal to PC from P and P_0 as centers, determine the point O equally distant from P and P_0, and with O as a center and the same radius, describe the arc PP_0. Determine the point O′ so that $O'P = O'B$ and with O′ as a center describe the arc PM′ which would pass through B if continued. It is immaterial how you continue the arc from P_0 to N′ as it is in shallow water, but for the sake of symmetry I make $O''P_0$ equal one-third of OP_0 unless there is some tactical reason to the contrary.

The curve M′N′ is then approximately the correct limit of the A.P. zone.

ADDENDA.

I was extremely fortunate in being so situated that I had great opportunity to witness the combined army and navy maneuvers, and to make a careful study of the various problems of fire control and direction.

While there were many lessons to be learned in connection with these subjects, nothing that I saw changed in any way my views upon the principles involved in the tactics of fire direction. Many important lessons were taught as to the proper manner of applying these principles in actual warfare. These lessons, however, pertain more to the technical problems than to the tactical problems of fire direction. Several points are worthy of note, and I therefore submit the following addenda to my paper upon the subject of the tactics of fire direction.

1st. The absolute necessity for F.C. and B.C. battle charts was very apparent. On more than one occasion, batteries were ordered to open fire upon vessels entirely without their field of fire. The use of properly constructed F.C. battle charts would have rendered such a mistake impossible.

While battery commanders endeavored in many cases which came under my observation to assimilate their work to those of actual warfare, the need of some simple guide such as the B.C. battle chart, which would appeal instantly to the eye, was very apparent.

2nd. During all of the day attacks that I witnessed, the entire problem of fire control and direction could have been carried out in the most efficient manner. Targets were easily assigned and the application of all of the principles of the tactics of fire direction was simple and easily accomplished.

During night attacks everything was different. The enemy's ships would appear suddenly out of the darkness, and the time would not admit of any classification or regular assignment. The leading vessels must be assigned immediately; Class 10 targets would be assigned to a battery of 12-inch guns, and fire opened upon them, when suddenly a Class 12 target would be picked up by the lights.

Much of this difficulty was due to the improper location of search lights, and faulty use of the same. It was, however, manifest that exact identification and assignment will be extremely difficult at night. It is probable that assignment at night will have to depend to great extent upon the location of the batteries with reference to the direction of the attack. Let us assume that the attack is approaching from the left, it will often in such cases be necessary to assign the leading vessels to the right battery, and to assign the vessels which follow, in order from right to left; otherwise the battery lights will cross and interfere with accurate work.

The facts that targets must at night be assigned by lights and the loss of time resulting from careful identification, will probably render it necessary to consider all assignments at night as Class X leaving it to the judgment of the B.C. to determine the character of the target.

3rd. The great necessity for some system of automatic sights for use during the "fire at will" was very manifest.

Finally the one point which impressed me the most forcibly was the absolute necessity for continual drill and instruction in the principles of the tactics of fire control and direction.

PLATE II.

SILHOUETTE INDEX.

Not having time to prepare a Plate to exemplify one of these Indices, I give here simply the plan of construction:

VESSELS OF CLASS 12.

Here insert all silhouettes of the vessels of Class 12, pertaining to the navy of which this is the Index, with number of the silhouette. All of the silhouettes used will be numbered in one series so that no number will be duplicated in the same navy. Arrange silhouettes according to funnels.

VESSELS OF CLASS 10.

Here insert the silhouettes of the vessels of Class 10, same as in previous class.

VESSELS OF CLASS 8.

Here insert all silhouettes of vessels of Class 8, same arrangement.

VESSELS OF CLASS A.

Here insert all silhouettes of vessels of Class A, same arrangement.

VESSELS OF CLASS O.

Here insert silhouettes of all vessels of this Class.

VESSELS OF CLASS T.

Only one or two typical silhouettes of this class need be inserted.

I append hereto a list of the requisite silhouettes for the U. S. Navy.

SILHOUETTE LIST FOR U. S. NAVY.

CLASS 12.

1. *Arkansas*, *Florida* and *Wyoming*.
2. *Alabama*, *Illinois* and *Wisconsin*.
3. *Kearsage* and *Kentucky*.
4. *Indiana*, *Massachusetts* and *Oregon*.
5. *Maine*, *Missouri* and *Ohio*.

CLASS 10.

6. *Olympia*.
7. *Iowa*.
8. *Brooklyn*.
9. *California*, *Nebraska*, *West Virginia*, *Colorado*, *Maryland* and *South Dakota*.

CLASS 8.

10. *Puritan*.
11. *Monterey*.
12. *Texas*.
13. *Katahdin*.
14. *Columbia* and *Minneapolis*.
15. *New Orleans* and *Albany*.
16. *New York*.
17. *Charleston*, *Milwaukee* and *St. Louis*.

CLASS A.

18. A silhouette to represent all the light armored monitors.
19. *Wilmington* and *Delaware*.
20. *Bennington*, *Concord* and *Yorktown*.
21. *Isla de Luzon* and *Isla de Cuba*.
22. *Chicago*.
23. *Newark* and *San Francisco*.
24. *Philadelphia*.
25. *Baltimore*.
26. *Chattanooga*, *Cleveland*, *Denver*, *DesMoines*, *Galveston*, and *Tacoma*.
27. *Nashville*.
28. *Cincinnati* and *Raleigh*.
29. *Atlanta* and *Boston*.
30. *Detroit*, *Montgomery* and *Marblehead*.

CLASS O.

31. *Vesuvius.*
32. *Castine* and *Machias.*
33. *Marietta* and *Wheeling.*
34. *Annapolis, Newport, Princeton* and *Vicksburg.*
35. *Bancroft.*
36. *Dixie, Prairie, Yankee* and *Buffalo.*

CLASS T.

37, 38 and 39. Three typical silhouettes.

Where more than one name is opposite a number, but one silhouette will be required far all.

PLATE V.

The color scheme of the chart is as follows:

All areas in the field of fire which are passable by small boats only are colored with sepia, in whatever zone they may be situated.

The general color of the D. P. zone is yellow, the color of high explosive.

The general color of the Inter. zone is gray, an intermediate color.

The general color of the A. P. zone is red, the danger color.

The depth of the water is indicated by the depth of color. The deepest color represents water that is passable by all vessels including battleships. A lighter tint represents water passable by protected cruisers, unarmored vessels, gun-boats, etc. The lightest tint represents water passable by torpedo boats only.

The center line of all channels is indicated, and the local names of all channels and shoals are given. It is important that officers and enlisted men should become familiar with such names. Their use may be very valuable in identification. Thus it will often simplify identification to send such messages as the following: "Fire on leading vessel in East Channel"; "Open on torpedo boats crossing Cranford Shoal"; "1st fire command attack in Main Channel. 2nd, Center Channel, 3rd, East Channel".

Range circles are given for every 1,000 yards, the 5,000 yard circle being slightly heavier than the others.

The range at which "fire at will" should begin is indicated by a broken line. On the right near the battery is a penetration scale for Krupp armor, normal impact. On the left is a table giving the comparative value of other armor as compared with the Krupp.

The field of fire of the battery is marked by two lines with their azimuths. In addition there is an azimuth circle on the chart, with the B. C. station as a center. By means of this azimuth circle and the range circles, the B. C. ought to be able to to locate approximately a target at a glance on the chart, the instant he hears the range and azimuth called off. Such location will be sufficiently close for him to determine the character of ammunition to be used, and his line of attack.

This method of constructing the chart is somewhat difficult, and requires a knowledge of the use of water colors, which will probably not prove stable. Experiments are now being made in which colored water-proof ink will be used.

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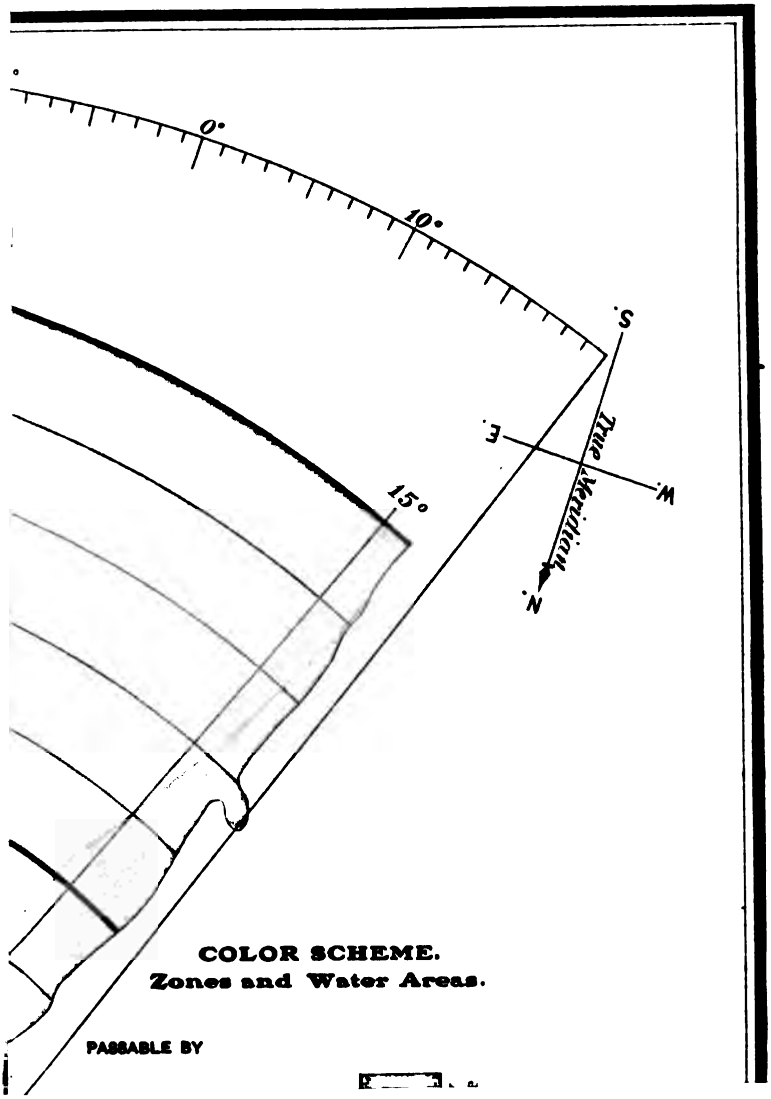

0°
10°
15°
S.
E.
W.
N.
True Meridian
COLOR SCHEME.
Zones and Water Areas.
PASSABLE BY

A GRAPHICAL CHART FOR SHOWING SIGHT DEVIATIONS FOR SEA COAST GUNS IN ACTION.

BY CAPTAIN HAMILTON ROWAN, ARTILLERY CORPS.

This chart forms one of a series of charts the object of which are to show, graphically, the amount of sight deviation for the various seacoast guns in action against both stationary and moving targets.

The chart here illustrated, see Fig. 1, is designed for the 10-inch B. L. R., with M. V. 1725 f. s., charge 214 pounds brown prismatic, shot 575 pounds, but the other charts are all constructed on the same principle.

TO CONSTRUCT THE CHART.

Use cross-section paper ruled 10 x 10 to the inch.

For stationary target:—Referring to the diagram on the right, draw a vertical line (in blue ink) at a convenient distance from the right hand edge of the paper. This line represents the *line joining gun and target*. It is also the line of sight when the sight is set at *zero*. On this vertical line lay off (scale of 1 inch = 500 yards) every hundred yards of *range* and draw horizontal lines across the sheet at every *thousand yards*. Refer now to a "Battery Commander's Table" for M.V. 1725, etc. From this table we see that if we aim directly at the target with sight at 0 deflection and assume there is *no wind* the shot (elevation being correct) will, at 9,000 yards range, fall 20 minutes to the right of the target on account of "drift". On the horizontal line corresponding to *9,000 yards range* lay off 20 minutes ($\frac{1}{10}$ inch = 1 minute) to the right of the vertical line and mark the point. In like manner and for the same reason on the 8,000 yard line we lay off 16 minutes, and so on at every thousand yards. Through these points draw a curve which will represent the line of "drift" or *no wind*. Lable this line "*0 wind*" and *drift* need *no longer be considered*. Again, reference to the B. C. Table shows that a 10-mile cross wind, at 9,000 yards range, moves the projectile 10.5 minutes to the right or left. Lay off this distance to the right and left of "0 wind" four times on the 9,000 yard line and mark the points. We now have the deflection due to 10, 20, 30 and 40 miles of cross wind. At 8,000 yards a 10-mile cross wind deflects 9.0 minutes. Lay this distance off on the 8,000 yard line to the right and left of "0 wind" as in the preceeding case, and proceed in like manner at every thousand-yard line. Through these points trace curves which will represent the deflection for every 10 miles of cross wind at every range. The eye can readily subdivide the distance between these curves to find the deflection due to a cross wind of 5 miles or less.

The diagram thus constructed shows at a glance just where the shot will fall due to any possible cross wind. A 60-mile cross wind will, for example, give a deviation equal to the sum of the deflections of 40 plus 20 miles of wind, etc.

To bring the projectile on to the line of fire, the muzzle of the piece (by means of the sight, or azimuth circle) must be moved to the left, or right, a number of minutes equal to the number of minutes of deflection right, or left, due to the existing cross wind.

SCALE FOR READING CHART.

To read the chart readily, construct a T-square and mark the point upon its edge that travels up and down the blue line (line of fire) "o". As the *points* of the Scott sight are equal to 3 minutes, lay off intervals of $\frac{3}{10}$-inch on either side of the "o" and number them 1, 2, 3, etc. As everything falling to the right of the blue line must be corrected by taking "points" to the left, the scale on the T- square is marked "*left points*" on the right of the "o" and "*right points*" on the left of the "o". To use this T-square run it up to the given range line and glance along its edge and find where it is intersected by the wind curve. The number of "points" of deflection will be shown by the scale.

The amount of deflection that should be given to the sight can thus be quickly determined without performing any mathematical work and without taking note of "drift".

For a Moving Target.—When the target moves in azimuth, or across the line of fire, sight allowance must be made *as in the case of a fixed target* and *in addition* we must take "points" (or minutes) ahead of the target corresponding to its *travel during time of flight of the projectile.*

Referring now to the diagram on the left of the chart: Draw a vertical (blue) line. This line (which is the line of fire) will be divided every 1,000 yards by the parallel lines previously drawn. By inspection of the B. C. Table it will be seen that at 9,000 yards *range* the *travel during time of flight* of a 10-mile-per-hour (10 m. p. h.) target is 43 minutes. Lay off 43 minutes (43/10 inch) on the 9,000-yard range-line, and mark the point. At 8,000 yards range the corresponding travel is 41.4. Lay this distance off on the 8,000-yard range-line. In like manner lay off the travel on every 1,000-yard range-line and trace a curve through these points. The 10 m. p. h. curve is now platted. Dividing the intervals at the different ranges between this curve and the blue line into 10 equal parts, and tracing curves through these points, we have the travel-curves of every m. p. h. up to 10. From these we can determine the allowance for any multiple or fraction of 10 m. p. h. travel. Extend the T-square and mark "0" the point of its edge cut by the last blue line drawn. Lay off points-of-sight ($\frac{3}{10}$ inch) to the left of this "0" and number them. The two diagrams can now be used simultaneously. To obtain the total sight allowance:—Run the T-square up to the given *range*, read the points corresponding to the existing *wind* from the right diagram, and the points corresponding to the rate of *travel* from the left diagram. Take the sum, or difference, of these points according as these points have like, or unlike, direction.

Example:

Range, 8,000 yards. *Wind*, left-deviating 15 miles.
Travel of target, 8 m. p. h. right.

From chart:

Wind = $\frac{1}{2}$ point left.
Travel = 11 points right.

Allowance = 10$\frac{1}{2}$ points right.

In the combination of the two diagrams the consideration of *drift* and *time of flight* is eliminated.

TO DETERMINE SPEED OF TARGET.

We seldom know the azimuth-speed of the target in advance, so this travel must be determined by observation. For making this observation we may use either the Scott sight or a pocket sextant, and in connection a stop-watch. With these instruments we find the *number of minutes of azimuth* the target travels in *10 seconds of time*. This observation may generally be more conveniently made with the D. P. F. in connection with the prediction-clock. As the marked interval in the latter is 20 seconds, divide the observed minutes of travel by 2. Knowing the rate of travel for 10 seconds, the travel in m. p. h. may be calculated. *To avoid calculation* construct 10-time-second travel-curves in the left diagram, that vary by 5′.

If the target, at 9,000 yards range, is traveling in azimuth at the rate of 10 m. p. h. it travels (see B. C. Table) 43 arc-minutes in 21.53 time-seconds (time of flight). In *one* time-second it will travel $\frac{43}{21.53}$ arc-minutes, and in 10 time-seconds it will travel $\frac{43 \times 10}{21.53} = 20'$ (19.97′). That is: If we by observation find that the target travels 20′ in 10 seconds of time we know it travels at a 10 m. p, h. rate and we can use the 10 m. p. h. curve at the various ranges so long as the target maintains its course and speed.

If a 10 m. p. h. target travels 20′ in 10 time-seconds, a 5 m. p. h. target will travel 10′, and a 2½ m. p. h. target will travel 5′ in the same time interval. We now have the origin of 5′ curves which we will mark in red ink. By calculation we find that a 10 m. p. h. target—

At 9,000 yards travels 20′ (19.97′) in 10 time-seconds.
" 8,000 " " 22′ (22.43′) " " " "
" 7,000 " " 26′ (25.75′) " " " "
" 6,000 " " 30′ (29.96′) " " " "
" 5,000 " " 36′ (35.93′) " " " "
" 4,000 " " 45′ (44.81′) " " " "
etc. etc.

By dividing the spaces at the different range-lines the 5′ curves may be traced.

The following is an example in the use of these curves:

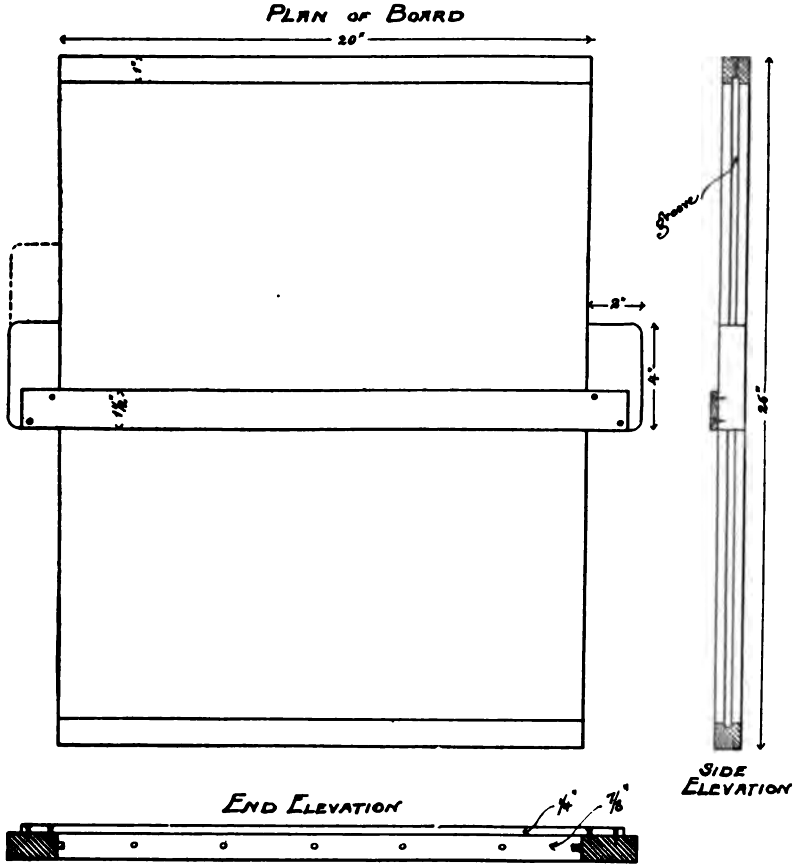
Range 8,000 yards. Target travels 10′ in 10 time-seconds. The 10′ curve cuts the 8,000-yard line half way between the 4 m. p. h. curve and the 5 m. p. h. curve. The travel is therefore 4½ m. p. h. Assuming that the target maintains that speed we may use the 4½ m. p. h. correction at the other ranges.

The space between the two diagrams is filled in with such data as the battery commander must have at hand to regulate his fire. When a shot is located he can at a glance determine what corrections in range or deflection is necessary. The column giving "travel of target in range" is to be used for set-back, or set-forward, purposes.

PRACTICAL USE OF THE CHART.

Pin the chart to a board having a sliding double-ended T-square. Adjust the chart so that the horizontal range-lines will be parallel to the edge of the rule and the blue lines coincide with the zeros on the scale. Such a board was constructed from the working drawing (page 275) without further explanation. The drawing is therefore believed to be self-explanatory. Practical use of this board indicates that the slide pieces might better be made 7 inches by 2 inches instead of only four inches long as in the drawing.

Synchronize two stop-watches with the prediction-clock. This operation may likely require several days and must therefore be done in advance of any firing. Start both watches *simultaneously* at the third stroke of the bell, and allow the three time-pieçes to run *continuously* throughout the practice. The battery commander retains one of these watches, and the other is laid upon the D. P. F. near the range-scale opening. The range-reader at the D. P. F. calls out "second minute" (or whatever minute the *small dial* on his watch indicates), and the platted point is numbered 1, 2, 3, etc., corresponding to the proper minute. The



Board For Use with Chart
Scale: ¼ inch = 1 inch.

range finding squad determines the predicted point for every minute, keeping about 5 minutes ahead of the actual firing. This data is telephoned to the battery commander who records it, or has it recorded by a clerk at his side. This record will appear like this:

Minute.	Range.	Minute.	Range.	Minute.	Range.
5	9440	8	8120	11	....
6	9000	9	....	12	....
7	8560	10	....	13	....

The gun is loaded and the battery commander glances at his watch and sees, for example, that the 7th minute has passed and that there are 30 seconds before the 8th minute. He decides to fire at the 8th minute. His notes show that the range at the 8th minute will be 8,120. Suppose the target travels 7 m. p. h. in range. The battery commander subtracts, or adds, 63 yards and calls to the chief of pieces "Range: 8,055". He runs up his scale to that range-line and calls out the number of points of sight allowance to the gunner. The latter sets his sight and lays his gun a little ahead of the target. As soon as the 8th minute is reached by the second-hand of the watch the battery commander blows his whistle, the gunner orders "halt" to the traversing detail and gives the command "*Fire*" when the target is opposite his vertical wire. The average delay in the case of four different gunners was found to be less than 3 seconds.

This method assumes that direct aiming is employed and that lanyard and primer are used. With indirect aiming and electric firing the modifications are obvious.

In indirect aiming use the lower edge of the T-square with a deviation scale reading minutes, or hundredths of a degree as lately proposed.

If there seems to be any merit in this method of determining sight allowance these charts could be lithographed, and the labor of preparing them for every battery avoided.

REPORT ON FIRE CONTROL AND FIRE DIRECTION, AND THE SYSTEM USED AT BATTERY CRANSTON, CALIFORNIA.*

By Captain W. G. HAAN, Artillery Corps.

Pursuant to instructions contained in "Report on Fire Control and Fire Direction," published by the War Department, March 14, 1901,† the system there outlined has been carefully followed by my company for more than three months.

The system has been followed in detail, with full permanent detachments for range predictions, communications and gun detachments, and, for the last two months, a full complement of officers.

A degree of expertness hardly hoped for has been attained by the range detachment as well as by the men at the guns and ammunition service.

The guns (10-inch disappearing) are loaded, simulating as nearly as possible, service conditions, using full weight projectiles and dummy cartridges, in one minute.

It requires four observations with the position finder (one minute duration) to get sufficient data to make a prediction, and then two minutes more to get the range and azimuth to the guns, the guns laid, and reported to the battery commander. The greatest possible rate of fire, therefore, will be one shot every three minutes. It requires almost invariably more than three minutes.

It is to be observed that from the moment a shot is fired, it requires an entirely new set of observations to get data for another prediction, and during the two minutes from the last observation to the moment of fire, no observations can, without materially modifying the system, or adding another instrument, be made for the next prediction. Each prediction is therefore made with precisely the same difficulties as the first one on a new target, for which G. O. 36 of 1901 allows fifteen minutes.

In order that this defect may be corrected, the system must be so changed that the instrument may be utilized during part of the two minutes to obtain the necessary data for another prediction. This might perhaps be accomplished by having an auxiliary instrument, say a type "B" position finder, for the battery commander, to be laid on the set-back point.

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* Publication authorized by the Acting Secretary of War.

† Report on Fire Control and Fire Direction, employed at Fort Wadsworth, New York Harbor, by Captain G. N. Whistler, Artillery Corps, U. S. A. Published by direction of the Secretary of War. Government Printing Office. 1901.

This, however, is not one of most serious defects discovered in the system, which to give accurate results requires the target to move with a uniform speed in a straight course. These conditions do not obtain as a rule oftener than one out of ten observations, even with the ordinary merchant steamers entering or leaving this port. Steamers here do not have to follow any particular channels because the bar is sufficiently deep for the largest ship over a wide area, and the harbor is large and deep at all points, consequently ships are not required to follow channels.

My position finder is about one thousand yards to the left of the battery, and predictions made for steamers coming in or going out are almost invariably out of place in azimuth, as seen from the guns, at the end of the prediction, with the result that at the signal "hit," indicating the instant when the shot should strike, the gunners, as a rule, report considerable variations right or left. This is due to the fact that steamers do not continue in a straight course and not to any inaccuracy of observation or prediction.

It also happens frequently that the ship, though changing course but little, necessitates the signal "hold fire," when new observations and predictions are necessary, with a consequent loss of three or four minutes of time, an important factor in an engagement.

The system presupposes perfectly trained range detachments for complicated and intricate work. The instruction of the detachment required is such as we can not hope to have even in time of peace, much less in time of war, when to man our guns the artillery will have to be materially increased with new and uninstructed officers and men, and many of the trained officers, either by choice or otherwise, will be called away from their station to do important work elsewhere. This has been the experience of the past and will undoubtedly be so in the future. It becomes therefore necessary to have as simple a system as possible, in order that new men may be quickly instructed in its use.

Blanks were made on which were recorded at the daily drills the results, and the blanks collected and studied after drill; defects were pointed out and all precautions taken to correct them at the succeeding drills.

Lieutenant V. C. Lewis, Artillery Corps, Range Officer, has with commendable energy devoted his entire time for two months, to the instruction of his range detail and communications.

He makes the following observations under date of March 20, "The range detail under my control has drilled for about two hours daily since the middle of January, (two months) and has attained as great a degree of proficiency in all points as I believe it is possible for an equal number of enlisted men to show.

* * * * * In my opinion this system presupposes the unattainable; that is to say, absolute accuracy in every one of a detail of seven men at the B. C. Station, It is quite possible for the instrument to be laid on the predicted point, the relocated azimuth and range for the directing gun corrected and transmitted, and the instrument again laid on the set back point within fifty seconds from the time No. 2 calls "stop"; but in order to attain this speed there must be an expertness, quickness of hand and eye and distinctness of enunciation in all of the observer sergeant, No. 1 and No. 2, which I believe can not be secured in the enlisted personnel of the Corps as at present constituted.

In a word I am convinced that the system throughout presents so many causes for error and delay, as to be an ideal, practically impossible of attainment under the present conditions."

It is to be noted that in the drills with Major Whistler's system, errors in deviation are more frequently observed than in range, and as I have observed myself, it is certainly discouraging to the gunner, as he is watching the target through the telescopic sight, to see plainly, when his gun is fired, that the shot will go wide of the mark.

Another fact has been brought to my attention by my battery officer, 1st Lieutenant R. F. McMillan; and that is the conduct of the gun and ammunition detachments. Lieutenant McMillan reports in part as follows: "In Case III., whenever the target materially changes its course, after the gun is laid, the fire has to be held, and the men seem to become inattentive and careless; this occurs very often. For the last two months I have been battery officer of the 28th Company and have seen constantly the drills under Cases II. and III.; to my mind there is no question as to which is best to follow. What I have particularly noticed is the behavior of the men. In Case II. they are busy and alert and take a great deal of interest. The number of times the gun is fired under this case is from two to four times as many as under Case III. The percentage of 'hits' is also much greater."

I have since, myself, noticed the difference in the apparent smartness and attention of the men and this I consider a matter not to be lightly passed over.

After long and close study in applying this system of fire direction, I am convinced that it has too many chances for error to be of practical value in its application for efficient fire direction in action.

I have made every possible effort myself to give this system a most complete test. I have also been materially assisted in this work by the advice of Major B. H. Randolph, Artillery Corps, Fire Commander.

The best men in my company were selected for the range detail and communications. They were thoroughly instructed and permanently assigned so that each man became conversant with every detail of his duties, and, I believe, performed them as well as can be expected from any thoroughly instructed enlisted man.

A comparison between this method and one of direct laying, using Case II. has been made for some time. The same targets, but different guns of the same battery, were used at the same time. The results, both in accuracy and rapidity of fire, were so decidedly in favor of Case II. that a system for the latter has been elaborated, or at least outlined, and is submitted for consideration with this report.

It will be noted that this latter system bears a close resemblance to the one used at Fort Monroe in the school target practice of a fire command, in July 1901, as outlined by Captain E. M. Weaver in the *U. S. Artillery Journal* for January and February 1902.

It is to be noted that with this no extra observation is necessary at the instant the shot strikes, for that is precisely the instant an observation is taken in the regular observations for prediction.

Most satisfactory results have been had at tracking drill using this method, and a comparison of the two seems to leave no room for doubt that the indirect method (Case III.) has no place for high power guns that can be served in less than three minutes. This includes all but the 12-inch mounted en barbette, and with a little improvement in the hoisting apparatus, this too, it is believed, could be served within less than the period required for prediction.

The great amount of time could be obviated by using two instruments, but inaccuracy can not be removed and I do not believe that in general, with the enlisted men instructed to even a high degree, good results can be expected.

There is no difficulty whatever under Case II. to have salvo fire and the battery commanders can order salvos at two, three or more minutes' intervals, since the ranges for every minute are before the gun commander and he can lay his gun for any interval directed. The 10-inch disappearing guns can be fired under Case II. for predicted ranges, salvo fire, without any difficulty every two minutes.

Other companies at this station have also tried the method of indirect laying, but I am told that their results are even less satisfactoy than mine.

In order to develop a satisfactory system of fire direction, it will be well first to see what information is required and what may be the simplest method of practically getting such information.

An efficient system may be assumed to fulfill the following essential principles:

1. The work of the range detail must be as simple as possible.
2. It must be the same for long, short or medium ranges, for a change from one to another invariably causes loss of time.
3. The work must be done rapidly and accurately.
4. The observer must be able to adjust his instrument for refraction as the target passes from long to short range or *vice versa*, without interrupting consecutive observations.
5. The information furnished at the guns must be equally good for rapid or slow fire.
6. The information must be such as to admit, without change, salvo fire or single gun fire.
7. It must arrive at the guns in time to permit the guns to be laid accurately before the end of the time for which the prediction is made.
8. It should show graphically range time relation.
9. The range and time for which prediction is made must be simultaneously registered at all the guns of the battery.
10. The system must not require instruments or communications more elaborate than we can hope to have under our present policy of economy.

Any system that will satisfactorily fulfill all the above conditions, is, it is believed, a satisfactory one, and it will not be necessary for the battery commander to concern himself with the range detail when he has satisfied himself that the proper target has been identified by the observer. He can then give his entire time to the general direction of his battery; in other words when once the range detail has started predicting it may be said to do its work automatically until a change of target is ordered.

Rapidity of fire must not be overlooked. As the volume of fire and speed of vessels increases, so must the rapidity of fire of our seacoast batteries, both heavy and light, increase, and our system of fire direction must be one that will admit any rate of fire possible to be attained with the guns, without interfering in in any way with the method of range prediction.

It is generally held that a certain stage of an action, there is no time for range prediction. That ground is not based upon sound reasoning, for the range predictions in a good system do not depend on how rapidly the guns are fired; the range with the corresponding time if placed before the gun commander every minute will always show him how to lay his gun for range and the gunner for the shorter ranges can lay his piece accurately in azimuth without taking into consideration drift or wind.

The following system has been successfully used at fire direction drill, at Battery Cranston, by the 28th Company, Coast Artillery.

The battery consists of five 10-inch disappearing guns.

Range detachment consists of range officer, observer sergeant, six privates.

The range detachment as soon the target is located, which is done as prescribed hereafter, furnishes to all the guns, simultaneously every minute, corrected range for two minutes ahead with the time for which the range is predicted, and the deflection allowance for drift and wind.

This range, time and deflection are, in each gun emplacement, written on a blackboard in parallel vertical columns by the receivers. The range, except for the directing gun, is corrected at each gun for gun difference by the gun commander.

The gunner, assisted by the time-keeper, makes corrections for movement of target, setting his sight accordingly; to this he adds mechanically deflection for drift and wind as recorded on blackboard. He has complete charge of the traversing detail and is responsible for its proper instruction. As soon as he has his sight set, he follows the target by traversing the gun, keeping the cross-hairs on the center of the target until his piece is fired.

When firing is by volley, the pieces are fired by signal of the battery commander's time-keeper; if by piece or at will, the piece is fired by the signal of the gun time-keeper; in both cases, previous to the end of the prediction equal to the time of flight.

This system is designed for use with appliances that can reasonably be expected, and not for some ideal system of communications, instruments and appliances that we can hardly hope to realize.

The following are some of the more detailed instructions given to the various parties making up the complete service:

PRELIMINARY PRECAUTIONS.

Previous to going to their stations, the range officer and battery officer will adjust their watches accurately with that of the battery commander. The battery officer will see that all time-keeper's and gun commander's watches are in adjustment with his own. Watches should be tested from time to time over the telephone; this can be easily done by counting the seconds of the battery commander's watch whereby the range and battery officers can adjust theirs.

For preventing all possibility of error as to time, a system of bells can be conveniently placed, one in each emplacement, which will ring from a push button in B.C. station. The bells will occasionly be rung on the full minute, a long ring, the end of the ring indicating the full minute.

POST OF BATTERY COMMANDER.

The battery commander's post will, if practicable, be in the position finder station or contiguous thereto. If the latter can also be so near the guns that the B.C. can observe his men at work, it will be a great advantage, especially at the drills when he is preparing his company for fire direction drill or action.

With the battery commander will be three men; an observer, a time-keeper and recorder, and a telephone man.

TO LOCATE TARGET.

In fire direction drill the B.C. sends to battery officer the command "prepare to locate target." The battery officer or his observer at Type "B" Position Finder prepares to identify the target.

The B.C. sets Type "A" P.F. about a minute in time ahead of target, relocates, and sends to Type "B" relocated azimuth and range, and as the target approaches cross-hair calls "ready" and "now" as the target passes cross-hair of the telescope.

The battery officer having satisfied himself that he has identified the target correctly sees that the gunners understand what the target is, and on signal from the B.C. loads pieces with prescribed ammunition and when predicted ranges are received, begins salvo firing at the prescribed interval or single gun fire as may be directed.

If salvo fire is used the guns will be fired, if communications are sufficient, by the B.C., the guns being reported ready to the B.C. giving time of prediction for which laid.

If single gun fire or fire at will is used, the gun will be fired by the gun commander at the prescribed interval. The time for firing in the salvo firing will be given by the B.C's. time-keeper, and for single gun fire by the gun time-keeper, in both cases previous to predicted time equal to the time of flight.

At fire control drill the target can be located at the guns and B.C. stations simultaneously by sending to Type "B" relocated range and azimuth from Type "A" as soon as that instrument is laid on the point predicted by the F.C. and the signal "now" repeated.

It is found in practice that no plotting is necessary for this but that with a little experience the observer in the F.C. station can lay his instrument sufficiently accurately by taking observation on target and then lay it ahead several degrees increasing or decreasing range according to speed and direction of target.

Observers should be frequently exercised in this work so that no time will be lost in beginning drill or action on account of inexperience.

MANUAL FOR TYPE "A" POSITION FINDER, CASE II.

DETACHMENT.—Range officer, observer sergeant, six privates, permanently assigned on the manning table.

Range Officer. Has charge of all instruments, implements, machines and stores relating to position finding; is responsible that all communications are constantly in perfect condition; has general charge of the instruction of the range detachment and all men at the communications. Reports to the battery commander only after he has personally inspected all instruments, communications, etc., that are to be used at drill or practice.

Observer Sergeant. If no tide gauge is on hand, constructs tide curve for the day; sees that all men of the detachment take their proper posts; sees that all blanks, pencils, charts and tables are in their places. Adjusts the position finder carefully; sees that barometer, thermometer, clock, anemometer and wind vane are in order. Is responsible for the minute instruc-

Name of observer will be entered in column of remarks by No. 1.

tion of all the men of his detachment, reporting all who are not suited to the position to which assigned. When everything is in order, he reports to the range officer, or in the absence of a range officer, to the battery commander. When target has been identified, he follows with telescope and at last ring of bell stops and relocates. When azimuth and range have been called off and recorded he follows target again, taking reading on each full minute. In passing from long to short range, or *vice vera*, he adjusts his instrument for refraction between observations; cautions plotter when target changes direction right or left, calls about the number of degrees of change.

No. 1, Private. Calls off azimuth and range as soon as relocated; sees that all observations are made on the full minute; records on his blank, Form "A", No. of observation, time of observation, range and predicted range, receiving the latter from No. 3's record if necessary. Writes in column of remarks, name of observer sergeant and plotter.

No. 2, Private. Makes first prediction for two minutes ahead, on plotting board after two readings have been plotted; he then makes two minute prediction after each observation. Calls off range only of predicted point as soon as found. (The plotting board should not be smaller scale than 400 yards to the inch.) Plotted points will be marked by dots and predicted points by dots with small circles around them. The plotter will be careful to observe from his plotted points the general course the ship is taking thereby avoiding abnormal predictions.

Name of plotter will be entered in column of remarks by No. 1.

(It may become necessary to have an assistant plotter.) The plotter will be assisted by No. 6 when the latter is not needed at F.C. communications.

Nos. 3 and 4, Apply corrections to range, for tide, $\frac{\delta'}{\delta}$, Privates. calculate deflection allowance for drift and wind. No. 4 hands to telephone man range, time of end of prediction and deflection allowance for drift and wind. No. 3 calls off from table, (same table as used in Major Whistler's report) corrections; No. 4 makes the calculations and applies to range as soon as called off by No. 2. No. 3 records on Form "B" No. of prediction, time of end of prediction, range, corrected range and deflection allowance. Nos. 3 and 4 are seated at a table alongside of telephone. During a series, barometer, thermometer, anemometer and vane will be read but once. Calculations for corrections are made as soon as the range is called off by No. 1, estimating the predicted range. No. 3 must be very careful to get his time column started correctly. First prediction being three minutes later than first observation ordinarily, No. 4 should keep memorandum of corrections and turn it in with No. 3's blank.

No. 5, Private. In charge of communications to guns. Sends range, time and deflection to guns. He must speak very plainly, enunciating clearly and distinctly and speak directly into telephone.

No. 6, Private. In charge of telephone to fire commander's station. Assists plotter when not needed at communications.

NOTE: The range officer will be very careful that the times are correctly recorded and sent. He will observe particularly the plotter, noting the general course of the steamer, and point out any errors, being careful not to interrupt work unnecessarily. He will see that there are no unnecessary delays. He will, especially at drill, see that all blanks are completely filled out and signed by the proper numbers.

He is authorized to change the members of his detail reporting same for correction of manning table. He will turn in personally after drill to the battery commander all records on blanks, to be compared with records at the guns.

No conversation whatever will be allowed in the P.F. station, except that relating directly to specific work of each number. There is no place where strict discipline is more necessary than here, and the range officer will be very careful to enforce it in the strictest manner, being careful to give his own instructions during predictions in the fewest possible words and quietly, in order that there may be no confusion or errors caused.

AT THE GUNS.

At each gun are two men, one receiver and one time-keeper and recorder.

The receiver, if telephone is used, should have head piece telephone receiver.

He writes on the blackboard, placed alongside telephone, in parallel vertical columns, range, time and deflection allowance, received over telephone, and indicates range time relation by making a cross in proper square of blackboard on same line with range.

The time-keeper and recorder writes on blank, Form "C", No. of shot, time, range, deflection, as written on blackboard by receiver. He records also difference chart correction, setting of sight for deflection and observed error in deviation, and gives time of flight to the gunner when called for as explained under the duties of the gunner.

DUTIES OF THE GUNNER.

He is responsible for correct laying of gun in azimuth. Has entire charge of instruction of traversing detail, and is held responsible that they clearly understand their duties.

To find correction of sight for movement of vessel during time of flight, gunner sets vertical hair of sight at zero. As soon as projectile is rammed home traverses gun so that the cross-hair points a little in front of the target and calls out "prepare to observe time of flight"; calling "one, two, three", as cross-hair is on any well defined point of target. At "three", time-keeper starts his watch and at end of time of flight for last range received, calls "stop". The gunner at "three" follows the point on target with vertical hair by turning translating screw of vertical hair until "stop"; notes reading on deviation scale of sight and moves vertical hair to corresponding reading on opposite side of zero. The sight is now set for movement of target. He now moves vertical hair from this point, a sufficient distance to right or left for drift and wind allowance as recorded on blackboard.

The sight is now set for deflection; the gunner calls off this and it is recorded by the recorder on Form "C". The gunner follows target by traversing the gun so as to keep cross-hair on center of target until "fire", at which signal traversing detail halts; the gunner follows target with vertical hair of sight until "hit" and then calls out reading of sight scale. The difference between this reading and the allowance for drift and wind, as recorded on the blackboard and Form "C," will be the error in deviation from the center of the target, and will be noted in proper column on Form "C" by the recorder.

NOTE.—The battery officer will give the matter of laying the gun his particular attention, noting what gunners obtain the best results; to this end he will place himself in a position so that at the command "fire" he can take the gunner's place and follow the target himself with the vertical hair until the signal "hit" is given by the time-keeper.

The best results may be expected by having, among the gunners, a strong competition in this matter, and the battery officers and 1st sergeant should promote the spirit of competition as much as possible.

A sergeant may be assigned to each gun to make the observation above outlined for the battery officer.

The gunner will have a gunner's range table on which is noted drift, 10 mile wind, and time of flight for each 500 yards of range. This can be used at any time to make approximate corrections for deflection as above indicated, when they cannot be obtained as there outlined. The time of flight is estimated by the gunner by counting seconds.

Gunners should be practiced in counting second intervals.

By examining this system carefully, it will be observed that it fulfills, it is thought, satisfactorily all the conditions laid down in the early part of this report.

This system was evolved gradually and built up entirely by the application of those methods in the various parts that answered best the purposes at practical instruction of the company at drill.

The plotting board, auxiliary scale, and correction table are the same, or practically the same as those described in Major Whistler's Report. The blackboard used is modeled after the one described by Captain Weaver, in his report of school practice of a fire command at Fort Monroe. The general system, however, is one worked out practically by my company, with the approval and assistance of Major B. H. Randolph, Artillery Corps, Fire Commander.

It may be noted that at the daily drills, without any apparent effort, all the necessary records are made that would be required of these details to fill out Form 31, as prescribed in G. O. 36, of 1901; so that if target practice were ordered, no change in the manning table would be required, and no records made except those that are daily made on the blanks furnished.

It is of course assumed that, at target practice, details are made from other companies to take the observations that are required to be made away from the battery as contemplated by Part VI, Drill Regulations, page 122, which enjoins that "The record should be made independently of, and as far as practicable, without interfering with, the work of the fire command."

It is assumed also, that the fire command will itself make all records necessary for its own information, to insure accuracy of fire, or in other words, make such records as it would require in action.

The object of all drill, including target practice, is to simulate action as nearly as possible.

This system of fire direction in its complete form has been practiced a comparatively short time, yet the ranges, time and deflection are recorded, at the gun emplacements, regularly in forty seconds after the observation is taken. As the communications are now, with a single telephone at the battery, the ranges, etc., are received in the relocator room and repeated from there to the emplacements by speaking tubes, causing a delay of four to five seconds.

In the appendix are samples of blanks used at the daily drills, also gunner's table and gun commander's correction table. The latter the gun commander uses for making his corrections for gun difference in range, instead of difference chart. The gunner's and gun commander's tables are pasted on a heavy card board and, being small, are conveniently carried at drill in the hand or pocket.

APPENDIX.

GUNNER'S TABLE.

10-inch Breech Loading Rifle.
M.V. 2025 f.s.
Wt. Projectile 575 lbs.

Range.	Drift, in Minutes.	10 Mile Wind, Minutes.	Time of Flight.
2000	2.1	1.4	3.18
2500	2.8	1.7	4.
3000	3.3	2.2	4.87
3500	3.9	2.6	5.8
4000	4.7	3.	6.78
4500	5.4	3.4	7.77
5000	6.2	3.8	8.8
5500	7.1	4.2	9.89
6000	8.	4.7	10.95
6500	8.9	5.1	12.09
7000	10.	5.6	13.25
7500	11.	6.1	14 45
8000	12.1	6.6	15.7
8500	13.4	7.0	17.
9000	14.7	7.6	18.3

While the piece is being loaded, gunner will make corrections for wind and drift and observe the travel of the vessel during time equal to time of flight of predicted range, making all corrections in minutes, and set his sight for total deflection. He will then cause the piece to be traversed so that the cross-hairs will be continuously on center of target.

This gunner's table is to be used only when deflection and wind are not sent by range detachments and recorded on blackboard.

RANGE CORRECTIONS.

No. 12 Gun.

Az.				
	50°	Plus	75	yds.
"	55°	"	70	"
"	60°	"	65	"
"	65°	"	60	"
"	70°	"	55	"
"	75°	"	50	"
"	80°	"	45	"
"	85°	"	40	"
"	90°	"	35	"
"	95°	"	30	"
"	100°	"	25	"
"	105°	"	20	"
"	110°	"	10	"
"	115°	"	5	"
"	120°	Minus	5	"
"	125°	"	10	"
"	130°	"	15	"
"	135°	"	20	"
"	140°	"	30	"
"	145°	"	35	"

Gun commander's correction table to be used in Case II. instead of difference chart.

FORM "A"
RECORD OF BATTERY DRILL.
BATTERY CRANSTON.

1902.

Observations.				Predic'd range	Errors observed				Remarks	Observations.				Predic'd range	Errors observed				Remarks
No. of	Time of	Azimuth relocated	Range relocat'd		O yds	S yds	R ′	L ′		No. of	Time of	Azimuth relocated	Range relocat'd		O yds	S yds	R ′	L ′	

....

.... A. C.,

Range Officer.

....

No. 1.

FORM "B"
RECORD OF BATTERY DRILL.
BATTERY CRANSTON.

1902.

Predicted.			Range corrected	Allow. for D & W + —	Remarks.	Predicted.			Range corrected	Allow. for D & W + —	Remarks.
No. of	Time of	Range relocated				No. of	Time of	Range relocated			

....

....A. C.,

Range Officer.

....

No. 3.

FORM "C"
RECORD OF BATTERY DRILL.
BATTERY CRANSTON.

Gun No. 1902.

Data of Shot Taken at Gun.								Errors.		Remarks.
No. of	Time of	Range of	Dif. chart cor.	Setting of sight + —	Allow. for D & W + —	Deviation observed		Dev. + —	Range. + —	
						R	L			

Gun Commander. Recorder.

REMARKS UPON THE REPORT OF CAPTAIN HAAN, ARTILLERY CORPS, ON FIRE CONTROL AND FIRE DIRECTION.*

BY MAJOR G. N. WHISTLER, ARTILLERY CORPS.

I would primarily invite attention to the fact that my Report on Fire Control and Direction at Fort Wadsworth was not intended as outlining a system for adoption by others, but as merely a report as to the method used at this post during the preceding year, it having been found that the system prescribed in the Drill Regulations was impracticable.

This was the first attempt made to carry out a detailed practice in fire control. It was to be expected that weak points would be found in the method, and it was for this reason that it was suggested that the method should be tested throughout the Corps.

It is unfortunate that Captain Haan has entirely misunderstood the spirit of the method. That he has not comprehended the scheme is manifest from the remarks which he makes in his report.

He says: "It requires four observations with the position finder to get sufficient data to make a prediction". This is not the case; predictions can be made from two observations, three observations or four as may be desired. Clear instructions were given in the Report for making one, two, or three minute predictions by means of the auxiliary scale from two, three or four observations. The three minute prediction from four observations was merely laid down as the method used at this post for preliminary instruction. The idea being that this rate was within the capabilities of any manning detail, and sufficiently rapid for the purposes of instruction. After a battery had become expert at this rate of drill the prediction was to be reduced to two or even one minute.

He says again: "Then two minutes more to get the range and azimuth to the guns, the guns laid and reported to the battery commander. The greatest possible rate of fire will be therefore one shot every three minutes".

This is also a mistake; no rigid rule is laid down except for purposes of instruction. Any time prediction may be used, and in fact the element of time may be ignored, and the predicted point be located at will; the observations being used only for the purpose of determining the rate of speed, and the general direction of the course of the vessel.

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* Publication authorized by the Acting Secretary of War.

He says: "It requires invariably more than three minutes". This is not understood, as at this Post we invariably have to wait for the vessel.

He says: "It is to be observed, that from the moment the shot is fired, it requires an entirely new set of observations to get data for another prediction".

This is not necessarily so. If the speed and direction of the vessel remain fairly constant, new prediction points can be determined without any further observations. If the speed remains fairly constant and the direction varies, predictions can be readily made from two observations 20 second intervals, the observations being used simply to determine direction.

The necessity for two instruments in the B. C. station has been recognized, and will be found prescribed in the report of the Wadsworth Board published in the *Artillery Journal.**

The errors which result from a correct use of the method will always be in range, and can never be in azimuth, as the gun is fired when the vessel is on the correct azimuth of the set-back point.

The astonishing errors in *azimuth* reported, can only be accounted for in two ways.

1. That the officers concerned did not understand the proper method of adjusting the Type "A", and consequently did not relocate their set-back point correctly.

2. That they conceived the idea that the vessel was expected to reach the predicted point exactly at the expiration of the predicted time.

Concerning the first, I would invite attention to the *Artillery Note* lately published, prepared by Major Pratt and myself on the Type "A," D. P. F.†

Concerning the second, it seems hardly possible that such a misunderstanding could exist, as the fundamental idea of the set-back system is that the vessel never does reach the predicted point exactly on time. The set-back system was devised to render the firing entirely independent of the time of the arrival of the vessel on the predicted point. It is entirely immaterial whether the vessel arrives on the predicted point at, before or after the predicted time.

If the set-back point is correctly re-located, the vessel is absolutely on the azimuth at the command Fire, and if the predicted point is also correctly re-located, it is impossible that the vessel could be far out of that azimuth when the shot strikes, especially as it is stated that there was but little error in range.

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* See *Journal United States Artillery*, May-June, 1902.

† *Artillery Notes* No. 3, 1902. Published at the Artillery School, Fort Monroe, Va.

The fact that such errors were found in azimuth, together with the statement that the system demands the unattainable, clearly demonstrates that the gentlemen did not understand the Wadsworth method.

Having placed myself clearly on record as to my views upon the subject of fire control and direction, as set forth in the Report of the Wadsworth Board, lately published in the *Artillery Journal*, I do not feel called upon to make any remarks upon the system devised by Captain Haan.

It appears to me, however, that many officers, carried away by the desire to devise technical methods of fire control and direction, fail to notice certain practical and tactical considerations which are fundamental, and must be taken into account in any system designed for practical use in time of war.

The importance of these considerations will, I hope, be accepted as an excuse for my going into the subject somewhat in detail.

FUNDAMENTAL PRACTICAL AND TACTICAL CONDITIONS WHICH SHOULD BE TAKEN INTO ACCOUNT IN DETERMINING THE PROPER SYSTEM OF FIRE CONTROL AND DIRECTION TO BE ADOPTED.

A. In time of war three (3) reliefs will be required for each gun. This is necessary for two reasons. As soon as the enemy is sighted off the mouth of the harbor, a relief of the manning detail must be kept at the guns and stations, continually day and night, awake and ready for action. The weight of ammunition and the rapidity of fire, the work to be done, will necessitate continual relief in order to obtain the maximum efficiency. Of course it is not maintained that the guns cannot be served with two reliefs, or possibly with one ; but three reliefs must always be considered as the normal, and every effort must be made to obtain that number in case of war.

Two reliefs and a single relief stand on the same basis as the service of a gun with a reduced detachment. It can be done but the maximum efficiency cannot be obtained.

In time of peace we cannot expect in our service to have sufficient artillery force to furnish more than one relief for the guns of 8-inch, 10-inch and 12-inch calibre, with possibly sufficient for one mortar pit in each mortar battery. We will never have sufficient men to man all of the rapid-fire guns at any station. In time of war we must rely upon green men or volunteers, and when we have distributed all of our trained gunners amongst all of the guns and mortars, and to each rapid-fire gun of whatever calibre, we will be fortunate if we have *one trained gunner per piece.*

One thing that we can have is a trained manning detail for the F. C. Station and for each B. C. Station.

The rapid-fire guns being practically fought by the gun commanders, it will be necessary to detail our best gunners for such work.

Again it is absolutely certain that all of our gunners as well as cannoneers will be men who have never been under fire.

We therefore start out with the practical condition that, in time of war, we will have:

Thoroughly trained manning details for the F. C. and all B. C. Stations.

Not more than one trained gunner for each piece, and he will be a man who has never been under fire.

To meet this condition:—

We must transfer all work involving judgment to the B. C. Station, and the men at the B. C. Station should be so thoroughly protected from fire that they will consider themselves safe. They must be so placed that they will not be distracted from their work, and they should not be able to see the fight. Everything must be done to insure cool and deliberate action.

Wherever possible automatic and mechanical devices should be substituted for mental operations.

At the guns everything should be made as mechanical as possible, and the men should be so placed that they can act with cool deliberation. They must be protected from fire as far as possible.

There will always come a time in any action when the fighting of the gun must be turned over to the gun commander to a greater or less degree. This should be delayed until the target has reached a range (about 3,000 yards) when no allowances are necessary, and where the use of judgment is reduced to the minimum.

A certain amount of accuracy can be sacrificed to ensure cool and deliberate action. The practical efficiency of the system will be increased thereby.

From the foregoing it is manifest that the ideal condition at the guns involves the use of a disappearing carriage and firing by Case III.

The gun commander and gunner will then be thoroughly protected from fire, and the gun can be laid in azimuth and elevation with cool deliberation.

It would be suicidal to adopt a system which expected a gunner (however well trained) who has never been under fire, to stand up on the sighting platform, and give the proper allowance in the proper direction, and to follow a vessel with cool deliberation, while under the fire of rapid-fire and machine guns, and amid showers of pieces of exploding shells.

It can readily be shown that, in consequence of the difficulty of accurately setting the sight on the standard, and the vibration of the sight standard, the utter impossibility of properly adjusting the telescope, Case II. is not as accurate as Case III., but even were it otherwise, in view of the impossibility of ensuring cool and deliberate action, Case III. should always be preferred to Case II. when it is possible to use it.

B. The idea seems to be prevalent that the proper method of artillery fire is to fire the guns as rapidly as possible, and to make everything else subservient thereto. General Order No. 36 in its method of target practice also clearly conveys this idea. This idea is however tactically unsound.

Naval attacks may be divided into three classes.

1st.—Bombardment for the purpose of silencing the forts.

2nd.—Bombardment with feint to run-by, to cover torpedo boat attack on the mine field.

3rd.—The run-by.

In the 1st class of attack, not only is rapid fire not necessary, but it should never be used. No ammunition should be wasted. The vessels will probably move in circles, and fire should be held whenever the target fails to pass within the danger space of the set-back point. Fire should be deliberate, and four minute interval (three minute prediction) is sufficiently rapid for all guns and mortars.

In the 2nd class of attack, firing should begin with four (4) minute interval, and be reduced to three and two minute interval, as the range decreases and the danger space increases sufficiently to admit of the more rapid work. Two minute interval will probably never be used beyond 5,000 yards.

It is in the actual run-by that rapid fire should be resorted to, and then only within 3,000 yards.

The use of high explosives in sea coast guns has materially changed the problem of harbor defense. The firing at long ranges should be so accurate and deliberate that no vessel will dare to approach within the short range zone.

It will be noted in the system prepared by the Wadsworth Board, that for all sites a combination of the D. P. F. and the H. P. F. method is used. It is assumed that at the extreme ranges, the H. P. F. method will be employed in order to ensure greater accuracy of fire.

As a rough rule for 10-inch and 12-inch guns:

Four (4) minute interval should be used between 12,000 and 8,000 yards.

Three (3) minute interval should be used between 8,000 and 5,000 yards.

Two (2) minute interval should be used between 5,000 and 3,000 yards.

Rapid fire within 3,000 yards.

By this it is not to be understood that the interval is to be exactly two, three or four minutes.

C.—At the B. C. station the method of work should be simple and accurate.

Each man must have his special work and be required to do nothing else.

All mental operations should be eliminated so far as possible.

All judgment should be exercised by the battery commander alone.

The battery commander should be so placed that he will not be distracted by the details of discipline or actual service of the guns from the all important work of fighting his battery.

In the system recommended by the Wadsworth Board, taken in connection with certain mechanical devices which have since been prepared, the guns of a battery are practically laid and fired from the B. C. station. The battery commander alone exercises judgment, and all other operations involve merely mechanical actions on the part of the various operators in accordance with the data furnished them.

The idea of the Wadsworth system, as recommended by the Board, is to obtain the greatest possible accuracy with the maximum efficiency, with poorly trained men at the guns and with but an average gunner. The B. C. detail is supposed to be of thoroughly trained men.

Any system which does not take these conditions into consideration must fail and break down in time of war.

It is not maintained that the Wadsworth system, as proposed by the Board, is the most accurate that could be devised for thoroughly trained gunners and cannoneers. It is claimed, however, that its accuracy is well within the accuracy of the gun itself; that it is practical, and especially suited to the conditions of the American service.

D.—In the attempt to apply the modern scientific methods to fire control and direction, it should never be forgotten that all such applications are essentially complications, and their use is never warranted unless it can be shown that greater *practical efficiency* is obtained thereby. The use of mechanical or electrical contrivances to obtain greater technical accuracy at the expense of practical efficiency is not sound artillery practice.

Any system that calls for expert operators, that involves synchronous action, that introduces the time element to an unnecessary degree, is of extremely doubtful value, and should never be accepted until practical experience has clearly demonstrated that the practical efficiency was increased thereby.

When more than one man is required to perform a certain operation, the liability of error increases in proportion to the square of the number of men employed. For ordinary work not involving the use of judgment, the liability to error can be reduced materially by the use of mechanical devices, but such devices must always be in the nature of simplification and the reduction of the number of operations to be performed.

Any method which depends for accuracy upon the simultaneous action of two or more men at certain intervals of time introduces a great liability of error, and should never be employed when it can be avoided. Men can readily be trained to act together simultaneously at a given signal, but anything that involves the use of watches or time recorders by two or more men increases the liability to error.

The errors of judgment cannot be eliminated by the use of mechanical devices. Therefore the efficient system which confines the use of judgment to the least number of men should always be preferred.

Finally, the system of fire control and direction should never be made to depend absolutely upon any machine which can possibly get out of order during action. It must always be possible to carry on the work in some manner, whatever breaks down, although of course it may not be carried on as efficiently.

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PROFESSIONAL NOTES.

ARTILLERY MATERIAL.

Improvement in Obturators of the De Bange Type.

This improvement relates to obturators of the "De Bange" type for breech-loading ordnance and aims to improve the construction of such obturators so that the liability of their pads to injury during use will be much less than heretofore.

For a gun having a swinging, screw-threaded breech block, with interrupted threads, the outer circumference or seat of the obturator pad (that is to say the part which fits radially against the breech chamber) is made conical or ogival in form, so that in the swinging of the block in opening or closing the breech the obturator will easily leave or enter its place within the breech chamber without requiring to be shifted rectilinearly. The said pad preferably consists of a composition of asbestos and mutton suet, covered with canvas, and is made in the form of a ring in the manner usual with the "De Bange" obturators.

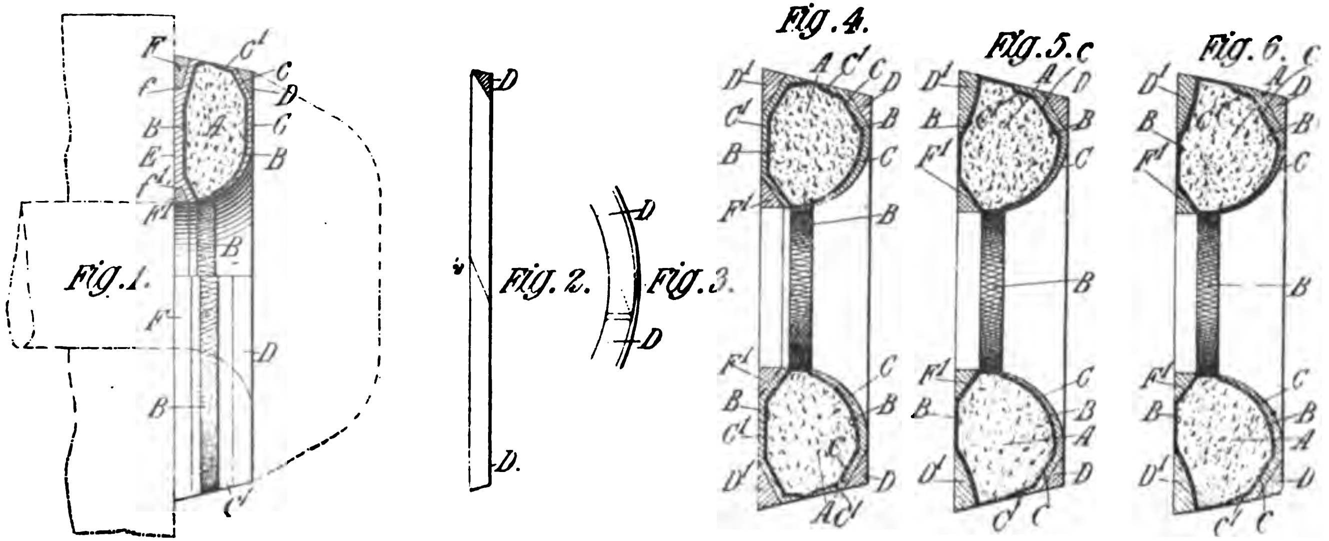
In such obturators experience has proved that during use the canvas of the pad is liable to injury, particularly at the forward circumferential part at the junction between the said canvas and the edge of the disks employed for protecting the pad. It is the chief object of this improvement to overcome this liability to injury by providing the pad with a protecting metallic cup or cups and a split ring or rings as hereinafter explained.

Figure 1 is a sectional side view of one form of obturator. Fig. 2 is a transverse section of the split ring used with this form of obturator. Fig. 3 is a detail face view of a portion of the said ring (looking toward the left of Fig. 2) and showing how its ends overlap. Figs. 4, 5, and 6 are sections of modified constructions of the obturator.

Like letters of reference indicate similar parts in all the figures.

Referring more particularly to Figs. 1 to 3, A is the body portion or pad of the obturator and B the canvas covering thereof. The front portion of the pad is provided with a protective facing or cup C of copper or other appropriate material interposed between the mushroom head of the obturator bolt (shown in dotted lines) and the forward part of the pad, said forward part being preferably beveled at *c* near its periphery.. The said copper facing or cup is also preferably flanged rearwardly to form a circular lip c^1, which will cover a part of the pad that would otherwise be exposed at the periphery. This rearwardly flanged portion may taper to a thin or knife edge. At the front beveled part *c* of the periphery of the copper facing or cup is provided a steel or other suitable split ring D which is preferably of triangular cross section to fit the correspondingly beveled portion of the copper facing or cup C, but which is not connected to the latter. The rear portion of the pad may be protected with a tin or other suitable metal disk E and steel ring F F^1 in the usual manner with "De Bange" obturators, these rings being secured in place by the dovetailed portion of the said metal disk E, which fits the annular dovetail groove formed by the inclined inner edges $f f^1$ of the rings.

With this construction of obturator, when the gun is fired the gaseous pressure generated therein causes the mushroom head of the obturator bolt to



Modification of De Bange Obturator.

exert great pressure on the pad, as is well understood, thereby compressing the latter and causing the copper facing or cup C and the steel split ring D to make a tight joint at the periphery of the obturator, and thus effectually to seal the breech opening of the gun. The action of the rear disk is practically the same as in the ordinary form of the "De Bange" obturator.

The special advantage of the copper facing or cup C is that, if the obturator does not truly fit the gun, the compression of the pad causes the said facing or cup to take a permanent "set" against the said seat, thus permanently compensating for any inequality of the fit.

The front split ring D insures a metallic contact with the periphery of the obturator, so that when rapid firing is effected the great heat resulting therefrom is conducted from the mushroom head to the gun by reason of the said metallic conduct.

The powder gases are prevented from attacking the pad at the point where the steel ring D is split by the pressure of the mushroom head against the copper facing or cup C. The facing or cup should be made of such thickness as to prevent injury to the obturator by successive intermittent pressures occasioned by rapid firing.

Fig. 4 shows the pad A provided with a copper or other appropriate metal protective backing or cup C^1 at its rear in addition to the front facing or cup C, and also with a rear split ring D^1 in addition to the front split ring D. In this case the rear rings D^1 and F^1 are not formed with the dovetail portions represented in Fig. 1, and the holding of the rings in place is dependent upon the obturator bolt and breechblock retaining the pad between them.

In Figs. 5 and 6, the metal disk E and the rear cup C^1 shown in the preceding figures are dispensed with, but in other respects the obturator is similar to those already described, except that in Fig. 6 it is of curved or ogival form on its periphery, the curve being struck from the axis of the hinge about which the breechblock swings.

The rear metallic cup C^1 and split ring D^1 (fig. 4) may be used without the forward cup C and split ring D if desired, and in some cases the rear split ring D^1 without the rear metallic cup C^1, or the rear split ring D^1 may be used with both the forward metallic cup C and the split ring D, or either of them. —*Notes on Naval Progress*, July, 1902.

Capped Armor-Piercing Projectiles.

Now that public attention has been drawn to the efficiency of caps on armor-piercing projectiles under certain conditions, a few remarks on the subject may not be out of place.

It may be well to discuss the general subject of penetration of plates before proceeding to the special one of capped projectiles. In former years, when wrought iron plates were attacked by steel projectiles, the latter usually remained whole, whether complete perforation was effected or not, though projectiles of inferior material or design often set up considerably in doing so. But on the introduction of compound plates, where the hard steel face was welded on to a wrought iron back, the superior hardness of the face sometimes caused the projectile to break up on striking; and with the advance to Harveyed or other hardened steel faces to the plates, up to the modern Krupp cemented plates, the tendency to break up the projectile has increased faster than the projectile makers have been able to meet it by improvements in their materials.

The problem with which the artillerist is faced is to a great extent indeterminate, and has to be met mainly in an empirical and theoretical manner, as the exact cycle of events in the penetration of a modern plate by a projectile moving at a very high velocity—from 2000 to 3000 foot-seconds—is practically unknown. Apart from complete shattering of the plate, which only occurs when it is too small superficially for the projectile by which it is attacked, penetration may be effected by punching or boring, the former being the most common, though connected by insensible gradations with the latter. In the extreme cases punching is effected not by the driving out of a cylindrical plug, as in the engineering acceptance of the meaning of the term, but by the removal of a more or less conical or mushroom-shaped portion of the plate, usually designated a disc, which is approximately of the diameter of the projectile on the face, and two or three or even more times as great on the back. The face of the disc presents a central depression, usually cup-shaped and almost hemispherical, but sometimes sub-conical, and in extreme cases the central cylindrical portion is partially punched through the disc. It would appear as though the latter action occurred early in the cycle of events constituting perforation, as the complete removal of a cylindrical plug appears never to be accompanied by the removal of the disc, the yielding of the plug removing the strains which tend to the separation of the disc, thus localizing the action. This punching action, in the limited application of the word, is not always clearly defined, the plug not always being recoverable after the perforation of the projectile. When it is found it usually has a considerable quantity of the head of the projectile in a disintegrated form welded on to its face, often to a thickness of several inches, but in other cases the plug is shattered and only recoverable in fragments, and it becomes difficult to determine whether the perforative action of the projectile has been by punching or by that action which, for the want of a better term, we have called boring.

When the projectile first strikes the plate the whole energy is delivered by the extreme point, and in most cases the latter is completely crushed out of recognition, the head of the projectile assuming a roughly hemispherical form, though in cases of oblique attack the extreme point for a length of ½ inch to 1 inch is sometimes recovered broken off and undamaged, having probably parted from the rest of the projectile immediately on striking.

In order to preserve the extreme point from damage so as to assist it in delivering the full energy of the projectile at the point of impact, the idea occurred of attaching to it a cap of soft, but tough, steel. Such caps are either cylindrical in form, or may follow the ogive of the point, and are attached by various methods, mechanical or magnetic, most of which form the subject of patents.

Just as the precise cycle of events which takes place in the perforation of a plate is not clearly known—for example, to what extent the plate backing springs on being struck, or at what stage the disc or plug yields, or the projectile breaks up—so the exact nature of the assistance which the cap affords is the subject of much discussion. Its primary action is doubtless that it holds the point together sufficiently long to enable a much greater proportion of the energy of the projectile to be delivered on the plate than is the case with an uncapped projectile, but it no doubt also acts as a lubricant; not only for the passage of the projectile in the direction of its axis, but also for its rotary motion, the stresses due to which are doubtless very considerable when the head becomes welded into the plate, while the rotation of the body tends to continue. So long as the projectile holds together this rotary stress can have no effect on the perforation, but it is one of the stresses which breaks it up, an action which it is desirable to prevent or postpone as long as possible.

The use of a cap also has been supposed to affect the time element, by delaying the breaking up of the head of the projectile so that the plate yields before the projectile, but we venture to think that this also has an adverse effect on the body, which derives no benefit from the cap, and which, if given time, may set up or break before the maximum of energy has been delivered against the plate. The invention is by no means very recent, wrought iron caps having been tried on Palliser projectiles twenty-five years ago with a distinct promise of success, but we now appear to have fallen behind the various foreign countries in our introduction of caps, in spite of the various projectile makers' efforts to urge their use. Messrs. Hadfield, of Sheffield, have had some very successful trials, both in this country and abroad, of their capped projectiles.

The trials which have been carried out in this country by the War Department and the Admiralty have not, as a rule, been made public, but it is understood that, generally speaking, it has not been proved that any great perforative advantage has been derived for their use when the plates are attacked normally, a condition which would comparatively seldom present itself in a naval engagement, or the attack of ships from the shore, while in oblique attack a positive disadvantage has been shown. The latter objection appears to have been one that might have been anticipated. As the attack becomes more oblique, the more important it is that the point of the projectile should bite on the plate, whereas the interposition of a comparatively soft cap must cause a tendency to slip, besides forming more of a cushion to the blow than when the plate is directly in front of the point, as in normal attack.

The efficiency of the cap undoubtedly increases greatly with the velocity. Results published in America show that the efficiency in normal attack at 2500 feet striking velocity is nearly treble that at 1900, the increased perforation at the higher velocity being about 30 per cent. as compared with an uncapped projectile, whereas at the lower velocity it is only about 12 per cent. The recently published results at Eskmeals point to the same conclusion, and we venture to think that one reason our country has been slow to adopt capped projectiles has been that our trials have been carried out with velocities too low to show their advantages, but no doubt the War-office has also been influenced by that commendable caution which they always exercise in adopting any new invention before it has been thoroughly tested. Moreover, our standard armor-piercing projectile is a shell, the design of which is too weak to derive full benefit from the use of the cap, the higher work it is thereby called upon to perform tending to break it up more instead of increasing the perforation. —*The Engineer*, June 27, 1902.

The Cleland Davis Explosive Shell.

Following is a description of the improvement in shells invented by Lieutenant Cleland Davis, U. S. N. It is taken taken from the specification forming part of Letters Patent No. 687,611, dated November 26, 1901:

"This invention relates to an improved form of explosive shell designed to give a maximum strength or perforating power consistent with a maximum capacity for an explosive charge.

"When the point of the projectile meets the hard elastic face of the armor plate, there is an elastic dishing of the hard surface layer, so that the stress of impact is transmitted to the tough back, and the resistance of the whole area of depression is concentrated to oppose the advance of the projectile or materially reduce its velocity in a short space, and thus cause it to expend its energy on itself and break up along its weakest lines. Now the logical form of projectile, so far as power of perforation goes, is the solid shot; but the destructive effect of explosive shell is such that conditions demand a projectile that will carry an explosive charge even at the sacrifice of perforating power. I have observed in a large number of experiments against armor plate with the present form of projectile that the projectile breaks up by first upsetting or bulging in the region of the bourrelet, then giving away along longitudinal lines or in ribbon-like strips evenly distributed around the circumference of the bourrelet. Disruption along the transverse lines then occurs, and the tendency to rupture is enhanced by the rotation of the projectile. Thus when the point of the projectile enters a plate the head is held fast, while the tendency of the body to continue to rotate often causes it to break in rear of the apex of the powder cavity. From all this it would appear that the increase of the mass of metal in the walls of the shell causes the upsetting or bulging before described, when the velocity of the shell is materially reduced in a short space.

"The improvement consists, primarily, in so designing the interior or cavity of the projectile that its capacity for a bursting charge is increased, and at the same time the perforating power is increased by concentrating the weight in the line of attack. In other words the moment, and consequently the shearing tendency, of the metal in the walls of the shell is greatly reduced, and, furthermore, greater strength is given to resist the tendency of the rear end of the shell to twist off due to the rotary course when the head of the shell is embedded in the plate. The improvement is of especial advantage in cast steel explosive shell where a bursting charge of black powder is used and in forged-steel shell with a high explosive charge or with a powder or other explosive that develops a great pressure for a relatively small charge, such as picric acid and its derivatives. The interior of the projectile is as free as possible from angles, the various connecting surfaces being curved.

"It is my purpose to cast the shell about a suitable core or cores and to machine-finish it in the usual way, or the same may be forged, if preferred.

"By this construction of shell it will be seen that the front half of the shell, where the greatest strength is required, is made very rigid and strong, and thus gives greatly increased strength for penetration, and consequently greater perforating power. Moreover, the weight may be distributed more in the front half of the shell, causing it to fly truer, on the same principle that weighted arrow-heads are used. Moreover, by having this construction, thinner walls can be used and the capacity of the powder-chamber is increased for the same strength of the metal of the shell. Again, I believe that a better quality of manufacture due to the form of the shell may be secured and that this form of shell will cause it to break up into a larger number of pieces when exploded.

"The special advantages claimed for this form of shell are increased perforating power for the same weight of shell; increased capacity of the cavity, and consequently a larger bursting charge; combined with greater strength or perforating power, improvement in the quality due to its form, which makes it more susceptible to treatment from a metallurgical point of view, and improvement as regards disruption upon the ignition or detonation of the bursting charge, whereby the shell will break up in a relatively greater number of pieces."

There is danger that in avoiding one difficulty Lieutenant Davis may run upon another. Will not the set-back of the shot on impact bulge out the rear of the shell so as to break it up if the walls are too thin?

—*Army and Navy Journal*, August 30, 1902.

Wet Guncotton as the Bursting Charge for Shell.

Naval and military authorities have for years past been, and are still, seriously occupied with the question of high explosives as the bursting charge for shell. Wet guncotton is known to be, in its wet state, a perfectly safe, uninflammable, and inert explosive in the absence of a detonating force. It may consequently be stored aboard ship, or conveyed and used with land forces, without any special precautions, and without the slightest risk from any cause whatsoever. It is absolutely under control. It will keep in any climate unimpaired for an indefinite period. Wet guncotton is not so locally violent as "lyddite," its disruptive effect and ensuing damage is therefore much greater. "Lyddite," too, is not employed in shell of a smaller calibre than the 4.7-inch gun, owing to the uncertainty of its detonation in smaller bodies. Wet guncotton, on the other hand, may be detonated in small as well as large quantities with perfect certainty. The only obstacle to its general use for shell purposes hitherto has been the circumstance that to ensure complete detonation a primer of dry guncotton and a fulminate of mercury detonator have been required, and both of these agents are too sensitive to premature ignition by friction heat or concussion to permit their employment under the conditions of shell-firing at the present day, owing to the high pressures and great velocities attained with modern artillery. The combination, however, is still the most useful and successful form for torpedo work, and constitutes the latest practice method of charging and exploding these submarine "shells" by all navies.

The means therefore of adapting the wet guncotton successfully for general shell work has long been sought, and after many years of experiment and research, the New Explosives Co., Ltd., of London and Stowmarket, have at last been able to place before the War Office a new safety exploder, the composition of which contains neither dry guncotton nor fulminate of mercury, but which will detonate wet guncotton with certainty under the safest conditions. The composition itself will not detonate under a temperature of 360 degrees C., and cannot be ignited by friction or shock, but at the same time is brought instantaneously into action with an ordinary detonating pellet such as is commonly employed in all percussion or time fuses of general service today. The force then exerted will detonate in its turn any charge of wet guncotton, without leaving any traces of unburnt explosive or residue. The composition is very stable and stands an excellent heat test, and it is not affected by any climatic changes, and in cost of manufacture it is less than guncotton.

Recently some extensive official trials were carried out by the New Explosives Co., Ltd., at the Ridsdale Range.

The main bursting charges were made by the Company's new method of forming and compressing wet guncotton, whereby it is now possible to produce charges of compressed gunpowder in one whole solid block of any dimensions, mechanically true, and of theoretical and uniform density throughout.

With the old method of work certain practical difficulties have prevented the direct formation of "shaped" blocks such as are required to form the bursting charges for shell and for torpedoes, and it has hitherto been the practice to build up such a charge from a number of discs, and to reduce them to the required shape and size in the lathe. By the new process such charges can be formed in a single block without any subsequent turning or other shaping being necessary.

There is no space wasted as is the case with built-up charges through slightly imperfect contact between the individual blocks, and thus, either a heavier charge (i. e., about 15 per cent more guncotton) can be got into the same space, or less space will be occupied by a charge of given weight.

The first experiment consisted of firing ten rounds from a 6-pounder quick-firing gun. The total weight of each shell as fired was 5 lbs. 10½ ozs., the weight of the wet guncotton bursting charge being 100 grams and that of the explosive in the safety exploder nine grams.

The shell was fitted with the ordinary Hotchkiss fuse, Mark IV. The target was a ¼-inch steel plate at a range of about 150 feet. In the rear of this were two heavy steel coils, forming a cell seven feet long, backed by a 12-inch plate, to confine the fragments, which were afterwards collected, counted and weighed. The propellant employed was ordinary government cordite, service charge, 7¾ ozs. The following table describes the fragmentation of the shell, and the chamber pressures and muzzle velocities for each round.

Rounds.	Chamber Pressure.	Muzzle Velocity. f. s.	Recovered of Shell.			Recovered of Brass			Recovered of Gas Check.			Largest Piece Recov'd		Total Weight of Shell Recovered.	
	Tons.		Pieces.	lb.	oz.	Pieces.	lb.	oz.	Pieces.	lb.	oz	lb.	oz.	lb.	oz.
1st	not taken	not taken	102	4	4	7	—	1⅜	3	—	⅛	—	4	4	5½
2nd	"	"	143	3	15	14	—	⅝	9	—	¼	—	8¾	3	15⅞
3rd	11.28	1,800	67	3	9	14	—	¾		none.		—	3½	3	9¾
4th	12.26	1,827	104	4	4½	6	—	¾		none.		—	6⅝	4	5¼
5th	12.39	1,838	154	4	2	10	—	1⅞	6	—	¼	—	6⅞	4	4⅛
6th	not taken	not taken	135	3	14½	8	—	1		none.		—	6⅛	3	15¼
7th	"	"	84	4	3	10	—	¾		"		-	7½	4	3¾
8th	"	"	222	4	3¾	9	—	⅜		"		—	7¾	4	4⅛
9th } 10th }	"	"	306	8	6	31	—	2½		"		—	6	8	8½

The second experiment was the bursting of a 6-inch shell at rest. This was done in a closed cell of wrought iron 7½ inches thick by 3 feet 6 inches in diameter by 5 feet deep, weighing 6½ tons, from which none of the fragments could escape, the main object in this instance being to demonstrate that the wet guncotton charge and safety exploder would act equally satisfactorily without the assistance of the shock of impact at a short range, and detonate as instantaneously and energetically (1) as if fired from a gun, and (2) in large as well as in small quantities. The results here obtained were also very much appreciated by all present. The force of the explosion burst the coil open. There were no traces of unconsumed explosive; the fragments recovered numbered 2122 pieces, the largest weighing 10⅛ ounces and the total 65¼ pounds.

The shell was an ordinary cast steel one, weighing, fully loaded, as fired, 119½ pounds.

The wet guncotton charge weighed 6 pounds 9 ounces, and the explosive composition in the safety exploder 300 grams. The fuse employed was of the ordinary service direct-acting pattern, and was fired electrically.

Before the trials commenced it was convincingly proved that the guncotton charges contained the usual amount of moisture, viz., about 18 per cent of water, and that there was no dry guncotton or fulminate of mercury employed in the composition of the safety exploder, and in view of the very excellent results obtained it seems highly propable that guncotton shell charges will become more generally employed, especially in armor and deck-piercing projectiles, for which purposes it appears to possess advantages which cannot be claimed for any other high explosives. With a delay action fuse wet guncotton with this new safety exploder can be fired through the thickest armor plate that the new shell itself will penetrate without exploding until it has passed through; this cannot be accomplished with "lyddite" or any other known high explosive. —*United Service Gazette.*

Krupp Safety Detonating Fuse.

This invention relates to projectiles for ordnance, such as shells, and is designed to enable this class of projectile to be transferred from place to place, handled, and fired with complete immunity from danger.

The ordinary shell, the bursting charge of which, as is well known, consists of some high-power explosive which is only detonated with difficulty, such as picric acid, gun cotton, dynamite, or the like, requires (in order to insure the bursting charge being detonated with certainty) a violent agitation to be imparted by means of a special igniting charge. For this purpose mercuric fulminate is most generally used, but as this compound is itself very easily detonated it gives rise to the dangerous possibility of its becoming ignited by the shock caused by the discharge of the projectile and so producing the bursting of the shell in the barrel of the gun.

For this reason shells containing an igniting charge of mercuric fulminate have to be carried about and handled with extreme caution, and even with the most careful handling accidents can not be avoided.

On this account various attempts have already been made to provide shells with other kinds of igniting charges in place of mercuric fulminate; thus, for example, it has been proposed to employ as a substitute for the mercuric fulminate a charge of rapidly burning gunpowder inclosed in a thick but brittle tube of cast steel or cast iron surrounded by the bursting charge.

Experiments therewith show, however, that by means of such an igniting charge merely a simple explosion is caused which only breaks the projectile into a small number of pieces, but does not detonate the bursting charge and therefore does not fulfill the conditions required of such shells.

According to the present invention, an igniting charge of gunpowder, or a mixture of materials which produce in combination a similar effect to gunpowder, is made to detonate the bursting charge with certainty by forming the igniting charge of separate portions inclosed in separate chambers placed one behind another.

In the accompanying drawings figure 1 shows in longitudinal section one example of a shell fitted according to this invention with an igniting charge in two parts. Fig. 2 is a second example of the invention in the form of a shell shown in longitudinal section with an igniting charge in three parts. Fig. 3 shows a shell corresponding to that shown at fig. 2, but with a slight modification of the arrangement of the igniting chambers.

Fig. 2.

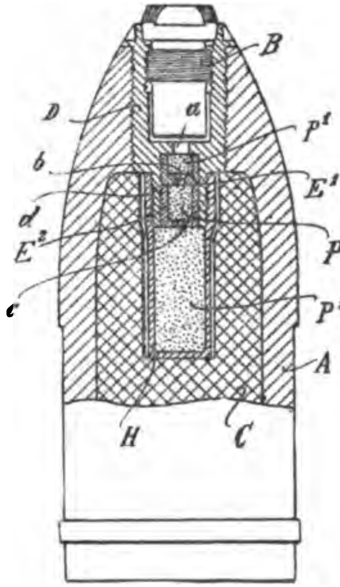


Fig 3.

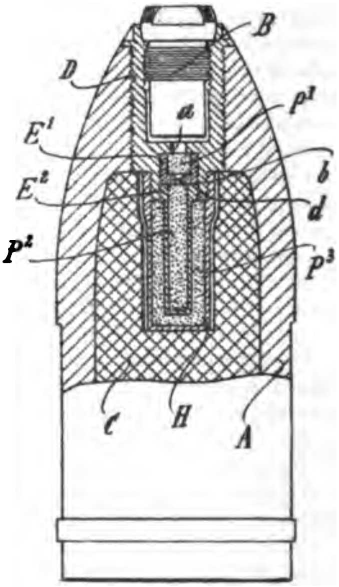
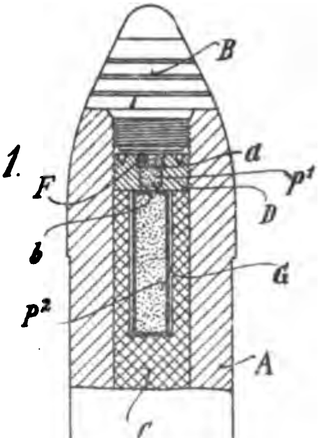


Fig. 1.



KRUPP SAFETY DETONATING FUSE.

In all three figures similar parts are designated by the same reference letters.

Refering to fig. 1 of the drawings the body A of the projectile and the fuse B, which is assumed to be a combination fuse, are of ordinary construction. Within the body A is placed the bursting charge C, consisting of picric acid or the like, and the hollow chamber containing the charge is closed by the screw plug D. This latter contains a chamber filled with the igniting charge P^1, which chamber communicates with the interior of the projectile by an ignition port *b*, and on the side next the fuse B is closed by a screw F, provided with an ignition port *a*. A second and larger charge P^2 is inclosed in a thin, brass tube G, the lid of which, next the igniting charge P^1, is provided with a fire hole, said tube being inclosed in a central recess in the bursting charge C.

When the shot is fired, the combination fuse B, whether it be used as a time or percussion fuse, explodes the igniting charge P^1, either at the proper time for which the fuse is set or upon the impact of the projectile, as the case may be. As this igniting charge P^1 is tightly inclosed in the screw plug D, it explodes with great violence, and thereby causes the immediate explosion of the second igniting charge P^2. The explosion of this latter, being itself produced by a violent explosion, takes place with increased violence and thereby imparts a sufficient exciting effect to the bursting charge to insure its ready detonation.

The shell illustrated in fig. 2, with the exception of its size, and the fuse B, which is assumed to be a percussion fuse, differs only from that illustrated at fig. 1 in being provided with three igniting charges P^1 P^2 P^3 instead of two. The charges P^1 and P^2 are inclosed in chambers formed by screwing two tubular cases E^1 and E^2 into a cylindrical hollow in the screw plug D. The third igniting charge P^3 is contained in a capsule H, screwed onto the pin *d* of the screw plug D and projecting into a central hollow in the bursting charge C. The igniting charge P^1 communicates with the fire chamber of the fuse by the ignition port *a*, the charge P^1 with the charge P^2 by the ignition port *b*, and the charge P^2 with the charge P^3 by the port *c*.

The shell illustrated at fig. 3 only differs from that illustrated at fig. 2 in that the capsule E^2 is prolonged downward into a tube so as to reach down into the charge P^3. As by this arrangement the two charges P^2 and P^3 are concentric with one another and with the bursting charge, the ignition port *c* (shown in fig. 2) may be omitted.

The method of operation of the two last-described shells corresponds to that of the shell shown at fig. 1.

When the projectile strikes, the fuse B first explodes the charge P^1, and the charges P^2 and P^3 then explode in succession and finally cause the detonation of the bursting charge C.

In order to render the action of the igniting charges in all three examples of shell described certain, it is important that the first charge P^1 be tightly inclosed on all sides. For the last charge this is not absolutely necessary. For example, the last charge (the one inside the bursting charge) may be inclosed in a paper case. The capsule H employed in the forms of shell shown in figs. 2 and 3 is of no importance in the working of the igniting charge and is only for the purpose of attaching the igniting charge to the screw plug and keeping all the parts together as a whole and enabling them to be easily inserted in the projectile.

As the materials (gunpowder and the like) employed in the present case as igniting charge can not be exploded by concussion, as is the case with mercuric fulminate, it is obvious that shells as above described may be carried about, handled, and fired with perfect safety.

—*Notes on Naval Progress*, July, 1902.

New Smokeless Powder.

Soon after the commencement of the Boer war it was discovered that the British service explosives—cordite and lyddite—were not as satisfactory as could be wished. Cordite was found to be eroding the larger field guns and naval guns, while lyddite proved to be by no means so formidable as was supposed in some quarters, and to be very capricious in its action. With a view to still further developing the power of the new service ordnance by way of improving the propelling agent, a committee was appointed to carry out trials with the object of ascertaining what were the best smokeless propellants for use in existing guns of all natures and in existing small arms. The committee was to report as to whether or not any modification in the existing designs of guns was desirable, with a view to developing to the full the power of any propellant which might be proposed.

One of the first acts of the explosives committee was to draw the attention of the manufacturers of propellants and high explosives on the home office lists to the work it was proposed to carry out. A letter was sent out inviting manufacturers to put forward for trial any propellants or high explosives which, in their opinion, gave reasonable promise of proving more efficient than the existing service article. All trials of explosives would be treated as confidential, and the manufacturing departments of the Royal ordnance factories would not have access to any powders which might be put forward for the purpose of experiment. The explosives committee has now been at work for more than a year and a half. During this period it has tested a large number of explosive compounds, and has carried out many experiments. The result of the committee's deliberations has been that a new service propellant has been evolved, which will shortly be introduced into both services. This new smokeless powder is known by the name of "Cordite M. D." As its name implies, it is a modified form of the present service explosive, and it is believed by the committee to be a powder better suited for guns than cordite itself.

"Cordite M. D." is now being manufactured, and if it turns out to be as satisfactory as the committee anticipates it will gradually replace cordite as the propelling charge, at any rate in the larger field pieces and naval guns. "Cordite M. D." has a nitrocellulose base. Cordite (so named from its cord-like appearance) was patented in 1889 by Sir Frederick Abel and Professor Dewar, and was adopted as the service propellant in 1890. Its composition is as follows:

	Per cent.
Nitroglycerin	58
Trinitrocellulose, with a small proportion of soluble gun cotton	37
Vaseline	5

The composition of "Cordite M. D." is, of course, an official secret, though it will doubtless be found impossible to prevent the ingredients and their exact proportions becoming known. Its base, as already stated, is nitrocellulose, and it is believed to contain a certain percentage, not more than 30, of nitroglycerin, but not nearly so high a percentage as cordite. The temperature of explosion of cordite is practically double that of nitrocellulose powder, owing to the large amount of nitroglycerin, a substance which on explosion generates a high degree of heat. This naturally has a serious effect on the bore of the gun. The wear of the bore at the beginning takes the form of erosion of very fine lines, which develop as the rounds are continued, completely washing away the surface, and enlarging the seat in the gun where the shot is rammed home. The pressure is diminished, the energy is reduced, the velocity is lowered, shooting becomes erratic, and finally the gun has to be sent away to be fitted with a new inner tube. Were it not for its erosive effects cordite would be the best propellant in the world. It is cheap, its keeping qualities are excellent, and it is really smokeless.

The effect of cordite can be best illustrated by the careful records which are kept at Woolwich Arsenal of every gun in the navy and army, a complete biography of its manufacture, the number of rounds fired, the effect produced on the weapon, and the repairs carried out from time to time. As an instance it may be mentioned that a 12-inch 50-ton gun, owing to the deleterious results caused by cordite, has its life at an end after about 100 rounds have been fired. Then it has to have the inner tube, that which takes the rifling, replaced.

Official notification of the change in the composition of cordite has been made to contractors who supply the Government with ammunition. The charges with the improved cordite for the various service weapons will be as follows: 4.7-inch quick-firing gun, 5 pounds 7 ounces; 12-pounder quick-firing gun, 1 pound 10 ounces; 6-pounder, 7¾ ounces; 3-pounder, 6⅔ ounces, and the 0.303 service rifle, 30 grains.

It is stated that "Cordite M. D." is not satisfactory to the British naval authorities and has not been generally adopted for naval guns, but is being adapted to only one, probably the 6-inch. The full advantages of the pure nitrocellulose powders are doubtlessly recognized by the British naval authorities, but the small chambers of the British guns, already in service, preclude the advantageous employment of powders containing no nitroglycerin.

EXPLOSIVES OF FOREIGN POWERS.

"Cordite M. D." will probably be found dearer and bulkier than cordite, but its freedom from erosive effects will make it the more valuable powder of the two. An expert recently said: "Nitrocellulose powder has the great advantage of being capable of producing in modern artillery the highest possible ballistics with the least possible amount of wear to the gun." This accounts for the fact that Russia, France and Germany have all adopted some form or other of nitrocellulose powder. The French service powder, known as "Blanche Nouvelle" or "B. N., ' consists of nitrocellulose, partly gelatinized and mixed with tannin, barium, and potasssium nitrates. Germany has now adopted a nitrocellulose powder, though until lately she used a form of nitroglycerin explosive. —*Notes on Naval Progress*, July, 1902.

Premature Explosions in Quick-Firing Guns.

The serious accidents which have repeatedly occured during the last couple of years in England, France, Russia and Sweden from premature explosions in quick-firing guns of larger calibers necessitate reliable explanation as to their cause and thorough research of means for their prevention. It is urgent that this should be done at once, because such accidents will evidently occur more frequently when the guns become worn by long service. Full light should be thrown upon all surrounding circumstances, without too much consideration for the feelings of contractors, and without giving too much weight to the question of cost of changing the present systems in case these should be found faulty. If due explanation of the faults and of the means by which they can be corrected is too long deferred, the change ultimately will become more expensive, the greater the number of guns of unsafe types that are meanwhile acquired, with the risk, of incalculable importance, that the gunners may become afraid of their own weapons.

The first step towards increased rapidity of fire was the adoption of breech-loading guns in lieu of the old muzzle-loaders. Many countries started with their own construction of breech mechanisms, but since the French breech screw, with interupted threads and with De Bange's gas-check, proved superior to Krupp's wedge, to which De Bange's system could not be applied, most countries have, like England, adopted the French type for ordinary breech-loading guns of calibers from 3-inch upwards. Next to the mitrailleuses, or machine guns, real quick-firing was first carried out in smaller single-barrel guns up to the 6-pdr., and the constructors of such guns gained the special detail experience of all the precautions which were found imperative for the safety of quick-firing guns using metal cartridges carrying their own means of ignition. For such smaller guns no trouble has therefore arisen from the use of metal cartridge cases, but when the necessity made itself felt to increase the rapidity of fire also of larger guns the difficulties commenced, several countries having tried to retain the interrupted screw in order to save expense, while inserting into it new firing arrangements and other modifications expected to suit quick-firing with metal cases.

This led to repeated accidents, and this system soon proved itself unsafe and unsuitable for quick-firing, when the powder charges were put into metal cases, and for the following reasons:

(a) The breech screw, on being pushed home with considerable force, strikes the base of the cartridge case so hard that the primer can be ignited by vibration; it has been proved that when a blow strikes the base at certain distances outside the primer the wave of vibration is almost sure to ignite certain types of primers.

(b) The firing pin in the center of the breech screw is always in line with the primer in the cartridge case, when the breech screw is pushed home; if the firing pin is fixed with its point outside the face of the breech screw (in case the firing pin is broken or held in that position by powder, dirt, or from other causes), the primer is struck and ignited by the protruding firing pin, before the breech can be safely closed by turning the screw into the threads of the gun.

(c) Recent official trials have proved that if the firing pin is not thus fixed, but rests free in its groove with the point protruding, the primer is nearly always ignited by the inertia of the firing pin, held forward by the initial pressure of its spring, when the breech screw is pushed home with force against a cartridge case fully inserted into the chamber. The firing pin can often be inadvertently left in this position, if it has slipped off the trigger comb; when certain parts of the mechanism may be broken; when the spring may accidentally not have been armed, etc.

(d) It may be said that accidents of this kind do not often happen, but they are sure to become more frequent when the guns become worn, and there appears to be no justification for continuing to make or purchase guns of a system which almost seems to invite accidents.

(e) Electric ignition for quick-firing guns with interrupted screw does not diminish the risk, because the contacts are also in line before the breech is closed, so that failure of electric action will cause ignition and premature explosion.

(f) In case of ruptured cartridge cases or pierced caps the interrupted screw does not allow of sufficient space for the escape of powder gases.

(g) Whenever premature explosions do occur before the breech is safely closed the accident becomes more disastrous, because the breech screw is held only by its hinge, and all the parts of the mechanism are projected out of the gun like so many projectiles.

(h) The inconvenience already experienced in ordinary breech-loading guns of this system of opening the breech by swinging the mechanism outside of the gun becomes still more serious with quick-firing; when the vessel rolls the breech screw is apt to swing to and fro like a banging door, with much risk of jamming the hands of the gunners.

For larger guns, above 6-inch caliber, metal cases may, perhaps, become too costly and quick-firing, at any rate, difficult. In such guns the De Bange gas-check gives much satisfaction and the risk of premature explosions can be minimized by introducing into the mechanism means of manifold safety, which with ordinary rapidity of firing there would be plenty of time for operating.

The most important question for the moment is how to make quick-firing safe in medium-sized guns, calibers from 3-inch to 6-inch. Pending definite decision upon this question, it has been suggested as a necessity to reduce the rapidity of firing by instructing the gunners to avoid all quick and violent movements; this seems to be an unreliable makeshift, as such instruction will soon be forgotten when the gunners are exposed to the enemy's fire. It has also been proposed to use the De Bange breech without metal cases, but this makes any attempts at real quick-firing quite futile and gives rise to other serious disadvantages. There will always be the danger of burning particles left in the chamber, unless it is carefully sponged out after each shot.

The accident on board the *Mars*, where metal cases were not used and ignition was effected by electricity, shows the danger of the silk bag, in which the powder charge was enclosed, being insufficiently ignited and left smouldering, until it flamed up on the access of air when the breech was opened. When a metal case is not used it is more difficult, and takes longer time, to ascertain that the projectile is fully home, failing which the erosion becomes greater, and it is possible that a shell with double-acting fuse may explode in the bore of the gun. The metal case is of considerable assistance for pushing home the projectile, and prevents the breech from being fully closed unless the projectile fully bears against the rifling. The powder cannot be so well protected in other ways as in metal cases, and upon thorough investigation of the entire question it will probably be admitted that the use of metal cartridge cases is, perhaps, the most important part of a really effective quick-firing system.

Many attempts have been made in recent years to solve the problem, and it is of interest that, while France was the first country in which the De Bange gas-check was used, that country seems again to be first in adopting into its army as well as its navy the apparently safest breech mechanism for quick-firing guns with metal cases, the excenter screw breech mechanism which has been adopted for the new French quick-firing field gun, and which—like

De Bange's breech—will probably soon come into general use in most countries.

The leading features of the system are said to be the following:

(1) The breech block is not pushed forward against the cartridge case, which is wedged into its proper position by the sloping surface of the excenter screw, thus removing the risk of premature explosion by vibration during the loading operation.

(2) The firing pin can never, even accidentally, be brought into line or into contact with the primer until after the breech is so far closed that no accident can occur from the firing pin accidentally striking the primer, or when fired electrically, from faulty electric action.

(3) There is consequently no necessity in the firing mechanism for any safety gear, which might be apt to get out of order or inadvertently become inactive.

(4) No risk is incurred from using metal cartridge cases carrying their own means of ignition if the primer is covered by a safety slip, which is removed only at the time of loading, or if the primer is inserted into the case after this is brought to the gun from the ammunition magazine.

(5) The powder charge is thus fully protected.

(6) As the breech cannot be closed until the projectile is pushed home by the metal case, the erosion will be the smallest possible, as well as the risk of explosion of shells in the bore of the gun.

(7) In case of a ruptured cartridge case, the powder gases are free to pass out through the open space, into which the breech-block is turned when the breech is opened.

(8) The excentric breech block always remains in the breech with as large a bearing surface for the threads when the breech is open as when closed; in the improbable case of premature explosion, the only piece that can be projected to the rear is thus the base of the metal case.

(9) The mechanism occupies no more space when open than when closed and there is no inconvenience for the gunners in a sea way.

(10) The excenter screw is used for several calibers, from that of field guns up to 5-inch and 6-inch.

The cost of metal cartridge cases over and above that of other means of protecting the powder charges, in the magazine and when carrying them up to the guns, is not of such great importance as has sometimes been said, because old cases would mostly be used for gun practise in time of peace. At any rate, metal cases are better means of obturation than even De Bange's gas-check. Perhaps the best argument in favor of mechanisms in which the cartridge cases are not subjected to blows and the firing pin is not brought into line with the primer until after the breech is closed, is the fact that while other countries are hesitating to use metal cases with the interrupted screw, Germany is said to contemplate the adoption of such cases for even larger caliber than 6-inch with Krupp's old wedge mechanism, which offers these two advantages, though in other respects not free from drawbacks.

If upon thorough investigation the above statement of the principal features of the excenter screw mechanism proves correct, that gun may be said to offer the greatest security against accidents, as its safety depends entirely upon the construction of its mechanism and is independant of any breakage of its parts, and of any failure of the gunners to follow instructions; or in other words, that the gunners cannot inadvertently make it dangerous for those who serve it. —*Army and Navy Gazette*, August 8, 1902.

The Use of Shields in Field Artillery.

We extract the following notes on this subject from an article published in *Militaert Gids.*

Field artillery should endeavor to take position as rapidly as possible and at the same time keep concealed from the view of the enemy. In order to come up without being seen, it will often be necessary to make detours and then bring up the pieces by hand. This requires much time. Hence it very often results that the two conditions, "to come into action rapidly, and to be hidden from view," conflict one with the other.

It is for this reason that some Powers have considered making use of shields that would afford protection to the cannoneers. During the late war, the English made use of shields that stopped 15 grm. bullets having a velocity of 600 m.; they were fixed to the carriage and could be raised or lowered at pleasure. Raised, they covered during the march the cannoneers seated on the limber; lowered, they protected the gunners and the breech mechanism of the piece.

These shields were made at the Krupp works. They are of steel, are 5 mm. in thickness, weigh 38 kilogr. per square metre and resist bullets of modern small-arms.

According to the author of the article, the shields offered more disadvantages than advantages in their use. They notably increased the weight of the material. If it is desired that the weight of the shield shall not exceed 60 kilogr., it should have relatively small dimensions, and would then give protection to only two men and that only from front fire. Moreover, the shields are distinctly visible at long distances.

The author concludes that the use of shields cannot be altogether advocated, and that field artillery cannot more efficaciously protect itself from the enemy's fire than by making judicious use of the *terrain.*

—*Revue de l'Armée Belge*, May-June, 1902.

Experiments with Shields on Field Guns.

The introduction of shields for the protection of men serving field pieces has, as might have been expected, been quickly followed by a counter move to restore to guns their offensive power. In Germany both Ehrhardt (Rhein. Metallwarenfabrik) and Krupp have an exhibit in the Düsseldorf Exposition by which they show how the protection offered by shields has been made of no value.

There are two entirely different ways: Ehrhardt, by the introduction of a light 5 cm. R. F. gun with explosive shell and by doing away with shrapnel the effect of which is shown to be insufficient,* Krupp, by perfecting the effectiveness of shrapnel. To this end, the shrapnel are filled with steel bullets in place of the mixed balls hitherto employed. While in the pavilion of the Rhein. Metallwarenfabrik such a 5 cm. field gun is exhibited, in the Krupp exhibit there are displayed several gun shields which have been subjected to the fire of the recent specially manufactured shrapnel with *steel* bullets.

We are able to give the following information as regards these firing trials that took place last June.

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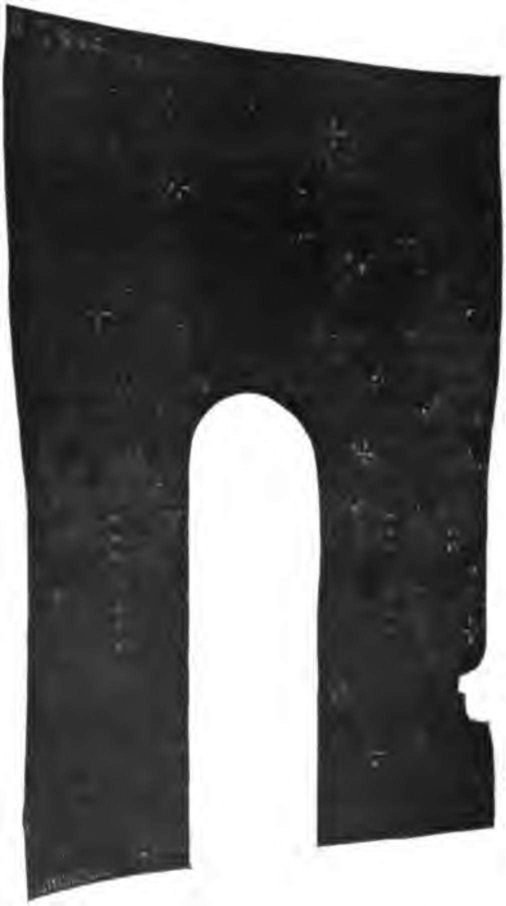
* In General v. Reichenau's Ergänzung zu Einfluss der Schilde, etc., (see *Book Reviews* in this number) the results of complete firing tests of armored shields by the 5 cm. gun with explosive shell are given in detail, but always under the supposition that shrapnel is and will remain ineffective.

The target was a field battery drawn up in the French manner (each gun and caisson close beside each other, both with shields*). It was fired at by a 7.5 cm. R. F. field gun. Projectile: shrapnel, weighing 6 kg., filled with steel bullets, 10 grm. Muzzle velocity: 500 m.; range: 3,500 m. Results: of 80 bullets which hit the shields, 63, = 79 per cent., went completely through; of the cannoneers placed behind the shields (8 standing and 8 sitting dummies representing gunners etc.) 13, = 81 per cent., were hit by a total of 62 bullets; of 76 bullets which struck the shields of the caissons, 13, = 17 per cent., went completely through, and of the 12 figures behind them (kneeling dummy cannoneers) 9 were hit (75 per cent.) by 14 bullets. Eleven shrapnel were then fired at the four carriages alone, with their shields. Of 55 bullets which struck 30 = 55 per cent. went completely through. In this way has Krupp proved that defensive shields are not safe against perfected shrapnel fire†, and that



SHIELD AFTER FIRING TEST WITH SHRAPNEL.

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* In *Stahl und Eisen*, in which this account is also given, it is stated that these shields were of chromium nickel steel, 3 mm. thick.—Ed.

† The fire against shields at a range of 2,000 m. with shrapnel which were filled with hard lead bullets gave no hits that penetrated.

in the artillery combat their value is illusory. Without doubt the means by which Krupp proposes to overcome the advantages of shields is by far simpler than the other; for in the first case only a new shrapnel is required while in the latter an entirely new gun is necessary.

—*Die Umschau*, September 27, 1902.

Lieut.-General Rohne, writing to the *Neuste Nachrichten* on the subject of protective shields for artillery, says: "The successes achieved by the Krupp factory with its shrapnels containing steel bullets against the protecting shields of field pieces seem to have created the impression that the protective value of the shields was thereby rendered illusory, and the shields, consequently, superfluous. This, however, is a very superficial judgment, which fails to take into account the special circumstances under which the favorable effect was produced. The shields, it must be explained, were only pierced when projectiles exploded in the comparative neighborhood of the object aimed at.* At a distance beyond 80 metres the explosion does no more than impart sufficient power to the bullets to penetrate through the shields, whilst the effect of a shrapnel shot against unprotected troops may still be called a good one when the place of explosion lies 150 metres in front of the objects aimed at, and bullets from shrapnels may disable troops even at an exploding distance of 250 metres and beyond. A great number of shots which, if fired against unprotected artillery, would prove effective, will fail to do any harm to field pieces protected by shields. At the trials mentioned, when all conditions were in favor of a successful result, nearly half of all the hits ricochetted from the shields without making any impression on them. How much greater will be the protection in warfare when such favorable conditions are never to be expected. There is another circumstance which must not be overlooked. Steel, as everybody knows, is specifically lighter than hard lead the material of which the present shrapnel bullets are manufactured. Steel bullets are, therefore, bigger than hard lead bullets of the same weight. A shrapnel of equal dimensions cannot in its interior contain as many steel bullets as lead bullets. Other conditions being equal, less hits will, therefore, be scored with steel bullets than with the present shrapnels. If, therefore, an adversary, in order to get projectiles piercing the shields, adopts other shrapnels than those now in use, the efficacy of his projectiles against all bodies of troops will be diminished. In this way the shields will benefit not only our artillery, but also our other troops. Instead of 300 lead bullets, the shrapnels of our opponent would contain only 260 to 170 steel bullets; and in the same proportion the hits scored by the enemy would be diminished--that is to say, the effect on unprotected troops would be increased by 10 to 12 per cent." *Army and Navy Gazette*, October 11, 1902.

AUTOMOBILES.

Military Automobiles.

Report of the War Office Committee, England.

The official report of the motor trials made before the War Office Committee in the course of its investigations upon the suitability of automobile vehicles for military service is a most interesting document in view of the recommendations contained therein, these, of course, being lacking in any previous discussion.

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* The shrapnel, in the trials referred to, had, on an average, a point of burst of 65 metres.
Ed.

It will be remembered that the requirements limited the trials to vehicles capable of hauling loads of 5 tons net, of which 3 tons was to be carried on the lorry itself, and 2 tons on a trailer, the fuel and water being additional. But five vehicles actually took part in the trials, four of these being propelled by steam, and one only bv an internal-combustion motor, this latter being entered by Milnes & Co., and equipped with a Daimler motor. Although all the various vehicles were installed at one time or another during the trials, this was only to be expected in view of the difficult ground and the severity of the tests. Since it was the intention of the committee to find out just which conditions were likely to interfere with the working of motor lorries in cross-country work the trials were arranged with that end in view.

The final report, some extracts from which are appended, brings out some interesting features. In the first place, although the steam vehicles did the best work in the trials, it is seen that the internal combustion motor appealed to the military experience of the judges very strongly, the independence of water supply, and the high fuel economy, being considered most valuable points. At the same time the use of highly inflammable fuels, such as gasoline, or petrol, is held to be out of the question, and heavy oil alone can be considered. This conclusion may lead to the development of an engine along the lines of the Diesel motor, since we understand that Herr Diesel has already equipped an automobile with his motor, and its capability of burning anything in the line of heavy liquid fuel should render it especially suitable for the exigencies of military service.

Another most important point in the report is the emphasis which it lays upon the demonstration of the fact that the existing road regulations are unnecessary for properly constructed vehicles. This may have a most important influence upon the general design of motor lorries for all kinds of service, and is most encouraging.

The following extracts from the official report will be of interest:

"The trials have shown that these steam lorries are good and serviceable machines suitable for present supply, and likely to be of good advantage to the transport service in countries where fuel and water in sufficient quantity is available. The committee, however, desire to call attention to the great possibilities for military purposes of the internal combustion lorry burning heavy oil, as shown by the small fuel consumption and practical independence of water of the one which was tried, belonging to George F. Milnes and Company, Limited. The committee strongly recommends that steps to develop such lorries be proceeded with.

"Compared with horse-draught, these trials have shown that self-propelled lorries can transport five tons of stores at about six miles an hour over very considerable distances on hilly, average English roads under winter conditions. The load transported by each single lorry (five tons), if carried in horse-wagons of service pattern would overload three G. S. wagons, requiring twelve draught horses, besides riding horses, whose pace would not ordinarily exceed three miles an hour. Moreover, the marching of 197 miles in six consecutive days over hilly roads would not have been accomplished by horses even at that speed without the assistance of spare horses.

"The committee are of the opinion that it has been demonstrated that mechanical transport of this nature has many advantages, and that it is well worth a much more extended trial.

"Regarding the type of lorry, the experience gained at these trials has caused the committee to somewhat modify their original views. On more than one occasion the disadvantage of the trailer in preventing the lorry from moving freely backwards when required was clearly noticeable. On the whole the committee consider that a lorry drawing a single wagon, while having the disadvantages accruing from the use of a trailer, does not obtain, owing to there being only one of these vehicles, the full advantages which should belong to the system, and they consider that for handy and rapid work of distribution among troops and near the front of an army a lorry without trailer is preferable. At the same time they consider that for the heavier work of moving stores in large quantities to the depots a powerful tractor, drawing a train of wagons behind it will be found most suitable.

"The committee therefore recommend that they be empowered to take steps to obtain for trial a lorry or lorries on the following lines:

"To carry three tons, driven by an internal combustion engine burning heavy oil only; weight as light as consistent with due adhesion; wheels large and broad, and fitted with a means for rapidly applying numerous 'spuds' for use on boggy ground. Speed up to eight miles an hour; large platform area.

"Finally, the committee beg to call special attention to the demonstration afforded by these trials of the entire harmlessness to roads of vehicles considerably exceeding in weight and road-speed the limits allowed by the present regulations on the subject, and also fitted with wheels to which road strips have been fixed, so long as these wheels are of large diameter and have tyres of considerable width. It has now been proved that the existing regulations are unnecessarily restrictive, whilst they stand in the way of the development of a most important method of transport and branch of industry."

—*Engineering Magazine*, November, 1902.

DRILL REGULATIONS, MANEUVERS AND PRACTICE.

Notes on British Naval Target Practice.

Much greater interest in good shooting is shown in the British navy. Admirable records have been made by the *Terrible* and the *Barfleur* in China, while in the Mediterranean other ships have accomplished excellent results.

Good practice is now being made at ranges never before considered, at any rate for real fighting, and evidently, if even 10 per cent of hits can be made at 5,000 yards and 5 per cent at 7,000 yards, it would be worth while, to open fire at the latter range, and possibly at the opening of an engagement.

The conditions of prize firing vary according to the nature of the guns. The 12-inch and 9.2-inch guns fire for six minutes only (the vessel steaming at 8 knots), at a range varying from 1,400 yards to 2,000 yards, and at a target of 15 feet height, 20 feet top, and 50 feet bottom, the whole giving an area of 525 square feet. The 6-inch quick-firing guns fire for two minutes (the vessel steaming at 12 knots), and at a range varying from 1,400 yards to 1,600 yards, at a target giving an area of 300 square feet. It will thus be seen that the heavy guns fire at longer range than the quick-firing, but their target is larger and the speed slower. On the other hand, as their rate of fire is slower, the distance varies more with the big guns than with the quick-firers. The function of the heavy guns is essentially to pierce the armor which stops the quick-firer's projectile, hence practice with the former is mainly judged by the number of hits, whereas the capabilities of the quick-firer are estimated by the weight of metal hitting.

Again, the efficiency of either type of gun depends upon the rapidity with which it can hit. Consequently, rapidity of fire must, or should, conduce to more hits, as there is less time for the distance to change between the rounds. Indifferent gunnery has invariably been ascribed to lack of practice by the gunners, and to improve this state of affairs one well-known naval officer has long devoted himself to perfecting a system of his own for training men to aim accurately. The system includes a "dotting machine" for training the pointer to keep the sights always on the object, independently of the rolling of the ship, and an extemporized loading apparatus, with which daily exercise is to be carried out.

The fact that Captain Scott's methods of training are being followed in other ships indicates that greater interest is now taken in aiming practice with heavy guns.

Notwithstanding the fact that the year 1901 gave some remarkable records of target practice in the British navy, the average record of this service for 1901 is little better than that for 1899 and 1900, the improvement being confined to exceptional shooting on the part of a few crack ships.

THE TERRIBLE'S LATEST PRACTICE.

The *Terrible* established the record last year at the annual prize firing with heavy guns (6-inch) by making a percentage of 77. This score was 20 per cent higher than the next best ship's performance in the British navy, and has now been beaten with a percentage of 80 for 6-inch guns, this being equivalent to the *Scylla's* record with 4.7 guns.

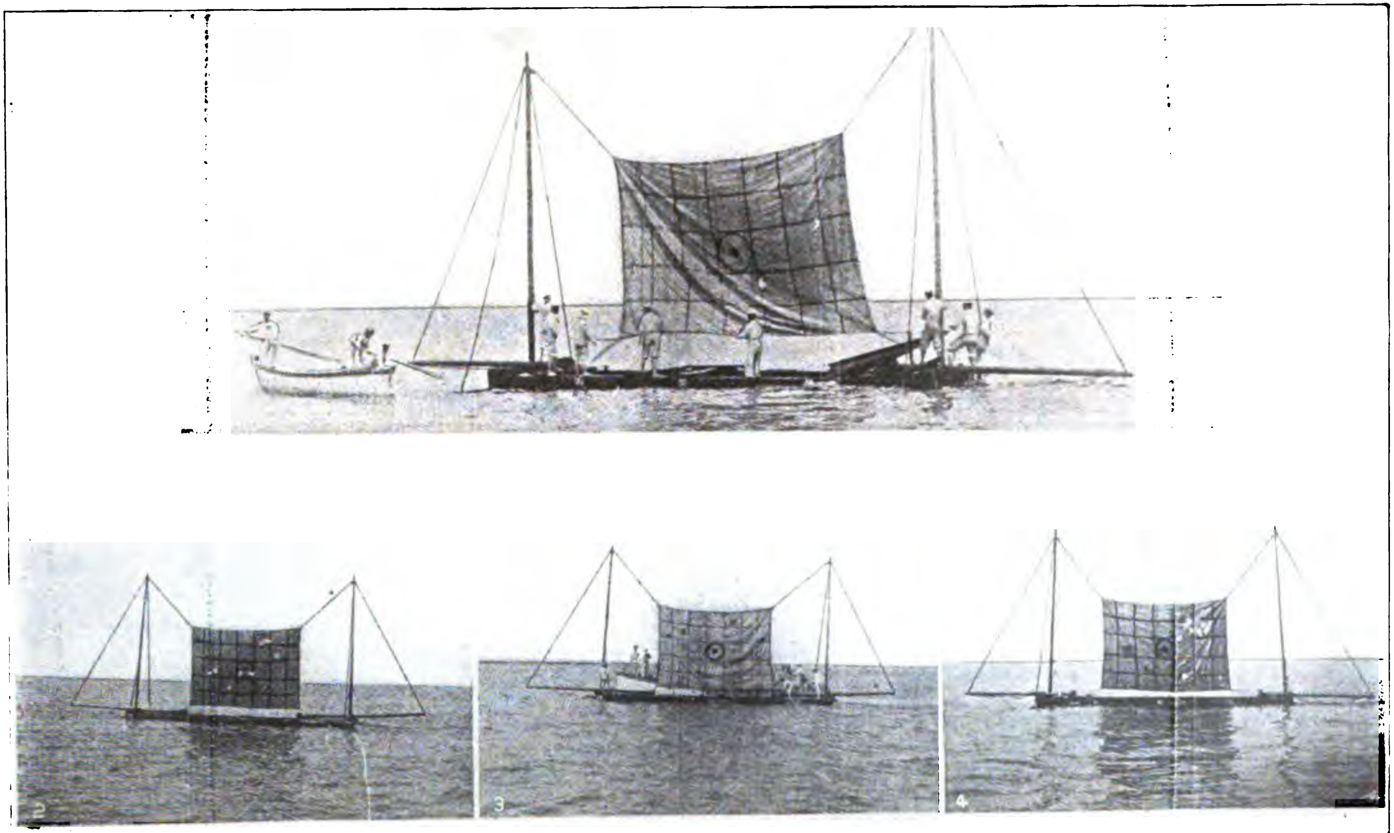
In 1900 the score was so large that many pardonably doubted the accuracy of the figures, owing to the great difference between them and those next in point of merit. But in order to obviate all suspicion regarding the results obtained on this occasion the time and marking of each gun were taken by several independent observers, in addition to the umpires. The regulations state that two umpires from another ship are to witness prize firing; the *Terrible* had five.

Analysis of Firing.

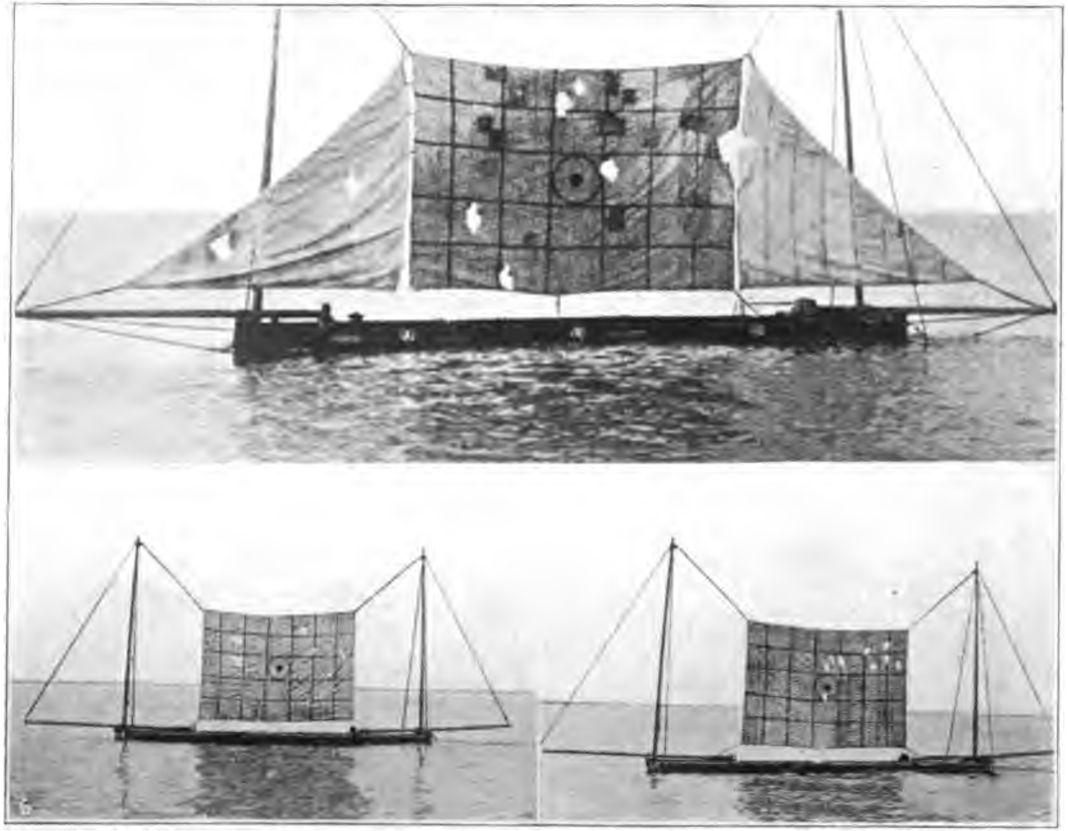
6-INCH GUNS (12).

Guns as fired.	Rounds.	Hits.	Percentage.
No. 1	10	10	100
2	11	8	85.7
3	11	11	90.6
4	11	9	88.3
5	11	9	87
6	9	7	85.7
7	10	10	87.6
8	13	8	85.7
9	12	9	82.6
10	9	6	79.5
11	11	6	78.8
12	10	9	79.6
Totals	128	102	79.6
Last year, 1900	104	80	76.8

REMARKS.—Duration of each run 2 minutes; speed of ship 12 knots; number of rounds per minute average 5.3; number of hits per minute average 4.2; ten men made possibles (each gun being fired by the Nos. 1 and 2, i.e., one minute each man), one man making 8 rounds 8 hits in his minute; weight of gun 7 tons; weight of projectile 100 pounds.



THE TERRIBLE'S LATEST PRACTICE.



THE TERRIBLE'S LATEST PRACTICE.—Continued.

Analysis of Firing.—Continued.

9.2-INCH GUNS (2).

	Rounds.	Hits.	Percentage.
F barbette	10	5	50
A barbette	12	9	63.6
Totals	22	14	64
Last year, 1900	15	9	60

REMARKS.—Duration of run 6 minutes; number of rounds per minute 1.10; number of hits per minute 1.1; weight of gun 25 tons; weight of projectile 380 pounds.

In the fleet the average hits per gun per minute with 6-inch quick-firing guns is 1.1. The *Terrible* made as much as this with 9.2-inch guns, and four times the number with her 6-inch guns.

The targets depicted in the accompanying illustrations of the *Terrible's* latest practice were of strict service dimensions, but two masts were fitted instead of three. The canvas was triced out from each corner, and no spreaders were used. The weather was fine throughout.

Petty Officer Grounds, who had always made a high score with the "dotter," and whose gun's crew was among *the best at loading drill*, made the maximum score with 8 rounds, 8 hits inside the minute. Petty Officers Taylor and Kewell scored 9 hits out of 12 from the after 9.2-inch gun.

The shooting and loading of the after 9.2-inch gun is worthy of notice. In six minutes this gun fired 12 rounds and hit the target 9 times, which is 1.5 hits per minute. This is more than the fleet average for 6-inch quick-firing guns. As it was anticipated that the firing would be more rapid than that generally accepted for 6-inch guns, and in order to avoid question regarding the results obtained on this occasion (for the shooting of the *Scylla* in 1899 and that of the *Terrible* in 1900 were barely credited in the British service), the time and marking of each gun were taken, as stated, by several independent observers in addition to the five umpires, though the regulations state that two umpires from another ship are all that are necessary to witness prize firing. —*Notes on Naval Progress*, July, 1902.

Interesting Russian Target Practice with Dummies.

A company of infantry and a battery of artillery were each duplicated by dummy figures, so arranged that each dummy would fall over when struck by a bullet.

The infantry company fired at the dummy battery, and the battery fired at the dummy infantry company. When a dummy fell over a man was at once withdrawn from the corresponding live company.

A series of firings were carried out, one at 2,000 and the other at 800 yards. At the longer range the fire was maintained for three minutes, the company losing 84 and the battery 9 men. At the shorter range the fire was continued for two minutes, the company losing 88 men, the battery 15.

It is to be borne in mind in comparing these results that the usual proportion of artillery to rifles in the army (British) is 4 guns to 1,000 rifles, while in this practice there were 6 guns to 90 rifles.

Other experiments have been carried out with a view to obtaining more information than has been hitherto available as to the effect which may be expected to be produced by musketry fire upon floating targets, as, for instance, upon boats carrying troops for disembarkation. The principal lesson learned from the exercise would seem to have been that judging the distance of a target and obtaining the correct range is far more difficult at sea than on land. Where the distance does not exceed 1,000 yards and the sea is smooth it is possible to observe where the bullets strike the water, even when the strength of the firing party is not large, and so correct the elevation, but where these conditions do not exist the determination of the range is not so easy.

The experiments near Odessa were divided into three series. In the first, the fire was directed against targets moving parallel to the shore; in the second, against targets approaching the shore, the firing party in both cases being naturally on shore; while in the third the fire was delivered by men on board ships against a target under three conditions—namely, (a) both ship and target being stationary, (b) the ship being stationary and the target moving, and (c) both ship and target being in motion.

In the first series of experiments, against a target moving parallel to the shore, the mark was a boat, such as would be used for disembarking troops, filled with dummies representing armed men. This was towed by a steamer across the range, and as a uniform distance from the shore was not maintained, the number of hits obtained, considering the size and conspicuousness of the target, was comparatively few.

In the trials against the approaching mark the same target was used. but it was now attached to a cable 2,000 yards in length, the other end of which was brought ashore and made fast to a carriage to which four horses were attached. These being driven inland, the boat was drawn toward the shore at the rate of about 117 yards per minute, or 4 miles per hour, and fire was kept up on it, by volleys, until it arrived within 700 yards of the firing party. The result obtained in this case was better than the preceding, 38 per cent of the bullets taking effect. According to the Russian authorities, the experiments have shown the necessity of more extended practice of the troops, who may be called upon to oppose an attempted disembarkation, in firing under the conditions in which they would then find themselves.

—*United Service Gazette.*

Rate of Fire.

The following summary of best results with heavy and quick-firing guns in the British service is given:

Best results with heavy guns.

[Target, 15 feet high; area, 525 square feet; range, 1,400-2,000 yards; speed, 8 knots.]

Ship.	Number guns firing	Caliber.	Firing time each gun.	Total shots fired.	Hits.	Hits, per cent.	Per gun per minute.	
							Rounds.	Hits.
		Inches.	*Minutes.*					
Ocean	4	12	6	26	15	57.9	1.08	0.6
Mars	4	12	6	26	11	42.0	1.08	.46
Barfleur	4	10	6	47	23	49.0	1.96	.9
Terrible	2	9.2	6	22	14	63.6	1.83	1.16

Best results with quick-firing guns.

[Target, 15 feet high; area, 300 square feet; range, 1,400–1,600 yards; speed, 12 knots.]

Ship.	Number guns firing.	Caliber.	Firing time each gun.	Total shots fired.	Hits.	Hits, per cent.	Per gun per minute.	
							Rounds.	Hits.
		Inches.	*Minutes.*					
Terrible	12	6	2	128	102	80	5.33	4.25
Ocean	12	6	2	115	64	56	4.80	2.67
Mars	12	6	2	112	62	55	4 67	2.58
Barfleur	10	4.7	2	159	114	71.7	7.95	5.7

In prize firing, during which the foregoing records were made, the practice commenced with the guns loaded. In order to get a more accurate estimate of the rapidity of fire, the time limits in each case above should be increased by the time required to load the gun at the beginning, or the number of shots should be reduced by one and the firing time in the fourth column above reduced by the actual time necessary to fire—i. e., to discharge the first shot. This would reduce the rounds per minute to the basis of an empty gun at the command "Commence firing." To be consistent and give credit where due, a gun loaded and ready to fire at the instant "Cease firing" sounded should be credited with a reduction in time by the elapsed time from the instant of firing the last shot to "Cease firing."

Brassey (1902) says: "A fair way of assessing the rate of fire is to take away one round from the total of each gun and deduct from the time for the gun, half the average time between two rounds, to allow for waste at the end."

The following table of rate of fire is given as being of interest:

Ship.	Caliber	Number guns.	Number rounds. fired	Elapsed time.	Time one shot.	Rate fire, shots per minute.
	Inch.			*m. s.*	*Secs.*	
Misaka	12	*a*2	4	…………	40	1.5
Do	12	*b*1	3	2 23	48	1.2
Formidable	12	*c*2	10	4 56	60	1.0
Irresistible	12	*c*2	10	4 46	57	1.0
Cressy	9.2	(*d*)	5	1 40	20	3.0
Experimental gunboat	9.2	(*d*)	5	1 30	16	3.7
Aboukir	9.2	(*d*)	5	1 25	15	4.0
Sutlej	9.2	(*e*)	5	1 40	20	3.0
Vickers's experimental range	7.5	*f*1	5	0 37	7⅔	8.1

a After turret. Guns not trained on target; fired for rapidity only. Average time from command "Load."

b Forward turret. Using one gun only, and starting with the gun empty and breech closed, just as it would be after having fired a shot, the ammunition being supplied under strictly service conditions, three rounds were fired at a target at a distance of 1,800 yards in 143 seconds. This gives an average of forty-eight seconds per round, and excellent as is the result it is only fair to add that it included delays amounting in the aggregate to no less than forty-six seconds. These delays were due in the first place to the hydraulic rammers being locked, a circumstance which was not noticed until after the trials had commenced; and in the second place to the fact that the captain of the turret temporarily lost sight of the target, owing to the approaching darkness (the hour of the trials was about 4.45 p. m., January 20.) If the lost period be eliminated it will be seen that the total time of loading and firing three rounds was only ninety-seven seconds, or an average of 32.13 seconds per round. The first shot lifted the target out of the water. The second was from 10 to 20 yards over, the third 10 to the left and 20 over. The target was composed of three small buoys with red flags on the staves. Hitherto, one aimed round per minute has been considered as an excellent result from a 12-inch gun.

c Guns fired alternately; both guns empty at start.

d Service conditions. From data given, assumed to be from one gun fired as rapidly as possible.

e Same as (*d*). Fired easily three rounds per minute.

f Fired at Vickers' experimental range. Gun loaded at commencement of time limit. Stationary platform for mount. The rate of fire of this gun is said to be much accelerated by the convenience of the loading tray fitted to the gun.

The following tables note some velocities and pressures of recent date:

Gun.	Weight	Charge.	Projectile.	Muzzle velocity.	Pressure	Energy.	Energy per pound powder.	Powder.
	Tons.	*Lbs.*	*Lbs.*	*Foot-secs.*	*Tons per sq. in.*	*Ft.-tons.*	*Tons*	
6-inch *a*..	7	34	105	2,844	17.9	5,890	173	Rottweil nitrocellulose.
6-inch *b*...	7	34	100	2,922	17.2	5,923	174	Do.
6-inch *c*..	7	29.6	100	2,922	....	5,923	200	Cordite.
7.5-inch *d*	15	80	200	2,903	15.9	11,700	146	Rottweil nitrocellulose.

a 6-inch, 45-caliber. Capacity powder chamber, 1,560 cubic inches.

b Same. Diameter cartridge, 6.5 inches; length, 31.2 inches; cubic contents, 1,033 cubic inches; size of gun chamber, 1,560 cubic inches.

c 6-inch, 45-caliber. Diameter cartridge, 6.3 inches; length, 22.5 inches; cubic contents, 701 cubic inches; size gun chamber, 1,820 cubic inches. Compare (*b*) and (*c*). Difference offset by erosion of cordite.

d Vickers' 7.5-inch, 50-caliber.

—*Notes on Naval Progress*, July, 1902.

ELECTRICITY.

Point of Cut-off in a Battery Discharge.

BY CARL HERING.

In making a test of a battery to determine its output in ampere-hours or watt-hours, the question necessarily arises, when shall the discharge be considered ended. The voltage of all batteries falls as the discharge approaches the end, and if this fall were a sudden and definite one, it could be taken as the proper "point of cut-off" of the discharge; but this is the exception, the rule being that the voltage falls gradually, without any sudden bend in the plotted curve, and it is then difficult to say when the discharge shall be considered to be ended; the point of cut-off is then necessarily an entirely arbitrary one. As the output in both ampere-hours and in watt-hours keeps on increasing, no matter how low the voltage has fallen, much depends on this arbitrary selection of this final voltage, when one is measuring the output of a cell. This is especially important when the output of batteries of different voltages are to be compared with each other, or when comparisons are to be made between the discharges of the same battery at different rates. It is evidently unfair to a lead accumulator, for instance, to always stop its discharge at say 1.8 volts, on closed circuit, when the discharges are made at different rates, or even when one discharge is made at constant current and another at constant external resistance. It is evidently proper to allow a lower final voltage for the higher rates, but the question then arises, what shall the different lower voltages be at these different rates of discharge.

In some cases the question settles itself, Batteries of the Leclanche or Daniell type, for instance, used on bells or similar work, are of use until their voltage is zero on closed circuit. In practice their drop in voltage will have to be replaced by fresh cells, but as long as they add anything at all to the voltage of the circuit, they are still of use. Zero voltage on closed circuit would, therefore, seem to be the proper point of cut-off in testing such cells.

When used for lighting purposes, the point of cut-off is fixed by the lowest voltage which is still sufficient to run the lamps at their proper candle-power, all above that is of no use, and must be wasted in regulating resistance, unless end-cell regulation is used.

With lead accumulators the point of cut-off of the discharge is generally determined by that fall of voltage below which the plates would be injured. But it is not generally known what this voltage is for different rates of discharge. Nor would it necessarily be the same for different types of lead accumulators.

In still other cases there may be other reasons which determine the lowest voltage to which a discharge should be continued, but there seems to be no general rule which is applicable to all batteries. An approximation to a general rule is to stop the discharge when the voltage has fallen a definite fraction of the original, say 10 per cent. The question then arises, what is to be taken as the original voltage; is it the e.m.f. on open circuit, or the difference of potential on closed circuit; if the latter, then at what time should that reading be taken, as there is always a rapid drop in the first few minutes. A good rule is to take as the original voltage, the difference of potential on closed circuit at which the curve begins to become nearly horizontal. But for a high resistance battery it would evidently not be fair to assume the same percentage drop for rapid as for slow discharges.

While there may be many cases in practice in which the differences pointed out above are too small to be of great importance, yet there are often cases in which it is very desirable to decide on some definite point of cut-off which is as fair to one as to another battery. This is the case when it is desired to compare with each other, the discharges of the same battery at different rates, or different batteries with each other, or different batteries at different rates.

The first thought was to try to find some curve, such, for instance, as that of an integral or a differential of some of the variables, which has a characteristic point like a zero, a minimum, a maximum, or an inflection point at the proper point of cut-off. A number of trials, however, gave negative results. Whether or not such a curve exists, the writer is not able to say at present, but if it does, it would probably involve too much calculation to be useful in practice, or the drawing of a new derived curve, which is troublesome.

For the particular case of constant potential, however, a simple solution was found, and as it does not involve drawing a new curve, and admits of a simple graphical solution by a trial method, it seems to be well suited for practical work. This solution is limited, however, to the case in which the battery is to be used on a constant potential circuit, as, for instance, for incandescent lighting, in which case all the voltage above the final is useless, and must be taken care of in the dead resistance of a regulator. The point of cut-off thus found then also gives the proper voltage at which this cell could be used for constant potential circuits; if, for instance, 110-volt lamps are used, then dividing 110 by the voltage thus obtained gives the number of cells required. If end-cell regulation is used, however, this method of finding the proper voltage, does not apply.

Referring to Fig. 1, which is an ordinary constant current discharge curve giving the voltages at successive times, it will be seen that the inscribed rectangles drawn at successive points, continue to increase from the beginning of the discharge up to a maximum and then diminish again. In this case the largest possible inscribed rectangle is *a b c d*. There is, therefore, a maximum of some quantity at this point. It will readily be seen that the area of this rectangle is the product of the volts and the time, or what might be called volt-hours; but as the current is constant, this area is also proportional to the watt-hours. In other words, at that point the maximum output in watt-hours will be obtained; beyond that point the voltage falls so rapidly that the total useful watt-hours begin to diminish, owing to the fact that all the voltage above that is useless. The discharge may therefore be considered ended at that point, and the useful watt-hours, for constant potential circuits, will then be a maximum.

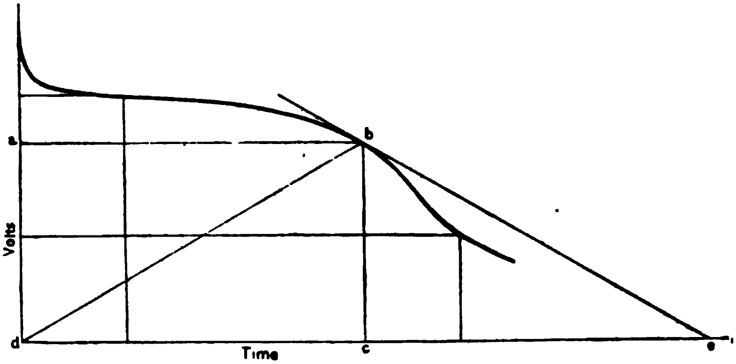


FIG. 1.

Locating this point by the differential calculus, that is, by making the first differential coefficient equal to zero, led my assistant, Dr. E. F. Roeber, to find the following very simple, graphical solution. It is a method of trials, but a very few trials generally suffice. He found that the angle of the tangent drawn at the point to be found, must be equal to the angle of the line from this point to the origin: from which it follows that the distance *ce* must equal *cd*. The rule therefore is, draw a trial tangent at what is thought to be the right point, then measure *ce* and *cd*, and if they are not equal, the difference will show where to draw a second one, and so on, a very few trials usually sufficing. This method applies only when the discharge is made with constant current, as usual, and not with constant external resistance. The voltage at the point thus found will then be that at which the battery may be used on constant potential circuits.

Although this solution applies strictly only to the specific case of constant potential circuits, it might nevertheless be used also in comparing different batteries with each other, or the same battery at different rates, even when they are not to be used on constant potential circuits, as it gives one a fixed definite point of cut-off, which is determined in the same way for all of them, and may be as fair for one as for the other. It is in any case better than an arbitrarily assumed point.

There is, however, another solution which may be still better; it is to discharge the battery at constant useful power: that is, at constant useful watts instead of at constant current or constant external resistance. This will be found to give a fixed and definite point, which is determined at once during the test, and requires no further calculations; the labor in making the test, however, is increased slightly. The current and the difference of potential at or near the start gives the power in watts; this power is then kept constant by so increasing the current during the discharge that when multiplied by the diminished voltage it gives this constant number of watts. Toward the end of the discharge the voltage will fall rapidly and therefore the current will have to be increased rapidly; this in turn makes the voltage decrease still more rapidly, and a fixed and definite point will, therefore, soon be reached, when the current becomes so great that the battery is no longer able to give that power; this is the point of cut-off, and it is a very definite one, leaving nothing for arbitrary determination.

Such a discharge at constant power seems to be quite a rational one when the battery is to be used for power purposes, as on automobiles, for instance; but for any good battery the difference between this and a discharge at constant current will not be very great during the greater part of the discharge; the difference becomes great only for a short time near the end.

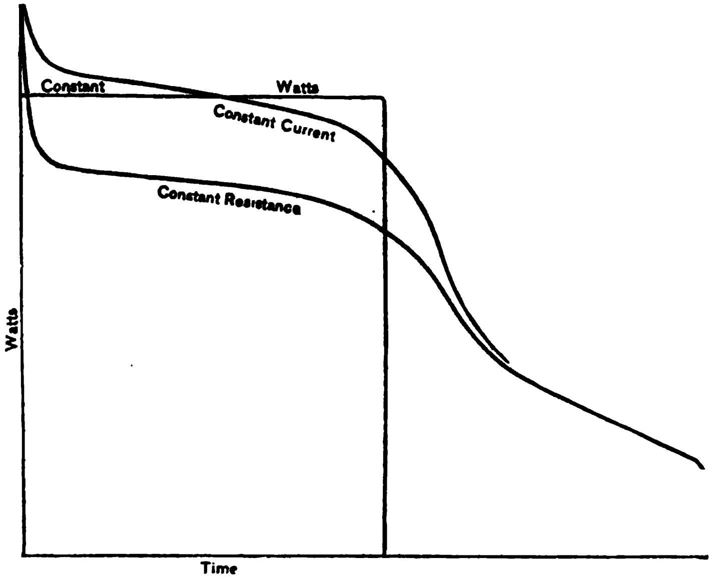


FIG. 2.

The test becomes somewhat more troublesome to make, for the reason that the current must be adjusted to correspond to the particular reading of the voltmeter, and the adjustment of the current again changes the voltage, thus requiring a re-reading of the voltmeter and a readjustment of the current; but with a little practice this is easily done. One ought, however, to calculate at the start the current that corresponds to each reading of the voltmeter, so that he does not have to take the time to perform the calculations for each reading, but can simply take it from the table. Such a table is very easily calculated with a slide rule; or, the slide rule may be used instead of the table, as the values can be read off directly.

Fig. 2 shows the curves for each one of these three methods of discharge; at constant external resistance, at constant current, and at constant useful watts. The same primary cell was used in all three, and all other conditions were kept as nearly alike as possible. It will be noticed how difficult it would be to select any definite point on either of the first two at which the discharge should be stopped, while for the constant power discharge the curve becomes a very definite rectangle, leaving no choice to the experimenter as to when to stop the discharge; it stops itself.

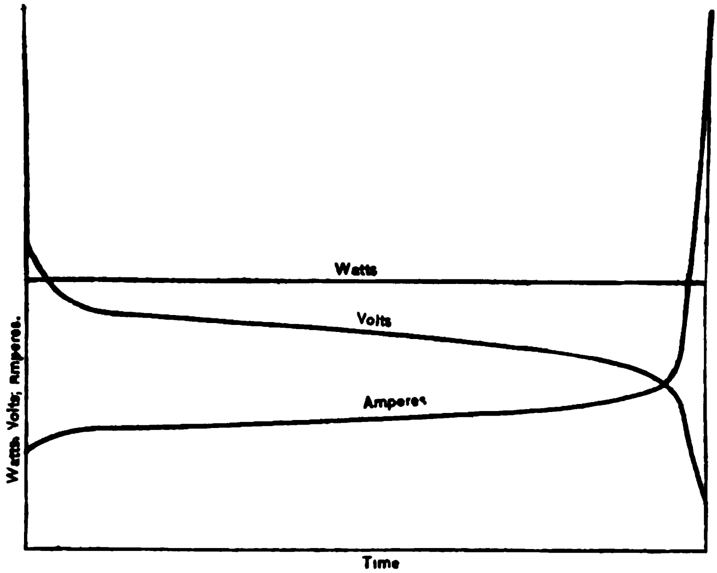


FIG. 3.

Fig. 3 shows the current curve, the voltage curve and the watt curve for this discharge at constant power. It will be seen how rapidly the current must be increased at the end of the discharge in order to maintain the watts constant as the voltage falls.

In making a constant current discharge of a few small cells, a simple and probably well-known method is to connect them to an ordinary constant potential incandescent lamp circuit in series with as many lamps as are required to give the proper current. The current will then remain practically constant and needs no adjustment as the voltage falls. There is no advantage, however, in using such a lamp circuit for a discharge at constant watts, as one ought to be able to adjust the current by very gradual steps. A carbon rheostat of very low resistances forms the best external resistance to use for that test. —*Electrical Engineers*, June-July, 1902.

Curves Showing the Available Capacity of a Lead Accumulator.*

ERNEST LUNN.

It is often necessary in operating storage batteries to tell on short notice how long a certain rate of discharge can be carried on the battery. If the battery be fully charged, this information can be quite readily had by consulting a curve made up from data depending on the capacity at various rates of discharge. This curve is commonly spoken of as the capacity curve. In laying out the plot the ordinates are arranged as rates of discharge in amperes. The abscissæ are the times in hours. The theory upon which the curve is based is that the available capacity of a lead accumulator increases as the rate of discharge decreases. The curve has the appearance of an equilateral hyperbola, but it is not, for the product of the two dimensions for any point is not constant, as it should be in hyperbolas of this form. By referring to such a curve it can readily be told how long any given rate can be maintained on the battery, provided it has not been previously discharged. In order to effect a simple calculation for a battery which has been partially discharged a set of curves is superposed on the capacity curve. These secondary curves are completed in the same manner as the capacity curve, the coordinates of the points making up the curves representing the same functions. They differ from the capacity curve in that they are equilateral hyperbolas, the product for the two dimensions on any curve being constant. It is this difference in the curves that makes the combination of value. By making use of the secondary curves, any discharge which may have been taken out at a constant rate or at various rates of discharge can be readily reduced to the rate at which it is desired to discharge. As an example, it is supposed that 5,000 ampere-hours have been discharged from the battery in various discharges, and it is desired to know how long a certain rate—say, 4,000 amperes—can be carried on the battery. The 5,000-ampere discharge curve is followed until it intersects the 4,000-ampere rate line. The distance between this point of intersection and the point where the 4,000-ampere rate line cuts the capacity curve is the length of time that 4,000 amperes can be carried. With the battery in the same condition, 2,500 amperes can be carried for the time shown by the distance between the points of intersection of the 2,500-ampere rate line with the 5,000-ampere discharge curve and capacity curve. It is not customary to work a battery near enough to its limit to make it necessary to consult such curves. It is, however, valuable in emergency cases to know how long a certain rate can be carried. Curves formed under these suggestions have repeatedly been found to be very reliable, and it is a source of no small satisfaction to the operator to know just how long the battery or batteries can be depended on to carry a given load when necessity so demands.

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* Abstract of a paper read before the Association of Edison Illuminating Companies, Mount Washington, N. H., September 9, 1902

--*Electrical Review*, September 27, 1902.

WARSHIPS AND TORPEDO BOATS.

The French Battleship République.

The *République* is the pioneer of a new type, of which six units are building or projected. These are the *Patrie*, *Démocratie*, *Liberté*, *Justice*, and *Vérité*. They mark a change in French shipbuilding policy, which hitherto has been to create isolated units all different. A break was indeed made with the three *Charlemagnes*, with the *Iéna* of practically the same type, but the *Suffren* and *Henri IV.*, each of totally different design, marked a reversion to the old plan. The *Républiques* are novel, too, in that they are nearly 3000 tons in excess of anything built for the French navy before. For many years France has adhered to that 12,000 tons of displacement which gives the maximum result per horse-power of machinery. Evolution has, however, compelled an advance in size, the end of which none can foresee. Very probably men will revert to 12,000 tons at some future date, just as in guns the 17-inch of years ago is now regarded as absurd, but that day is not yet. At present, size alone represents the way of carrying all that has to be carried. In the end, no doubt, just as we have learned to put more power into 50 tons of gun than we could put into 110 tons a few years ago, we shall acquire the art of getting more out of 1000 tons of displacement than we as yet have managed to achieve.

Below we give in tabular form the principal characteristics and details of the *République*, in comparison with the *Suffren*, whence she is evolved, and some other warships of equal date. It will be noted that armor is not given in these

Nation	French.		British.	German.	U. S. A.	Italian.
Name	*République.*	*Suffren.*	*King Edward.*	"*H.* and *J.*"	*New Jersey.*	*Vittorio Emanuele.*
Displacement	14,865	12,728	16,500	13,200	15,000	12,625
Length	439½	410	425	396	435	435
Beam	79½	70	78	73	76	73½
Draught (mean)	27½	27½	26¾	25	26	26
Big guns	Four 12-inch	Four 12-inch	Four 12-inch Four 9.2-inch	Four 11-inch	Four 12-inch Eight 8-inch	Two 12-inch Twelve 8-inch
Medium guns	Eighteen 6.4-inch	Ten 6.4-inch Eight 4-inch	Ten 6-inch	Fourteen 6.7-inch	Twelve 6-inch	— Twelve 4-inch
Small guns	— Twenty-six 3-pdr. Two.	— Twenty 3-pdr. Two.	Eighteen 3-inch Six 3-pdr. C. (?)	Twelve 3.4-inch Twelve.	Twelve 3-inch Eight 3-pdr. Sixteen	— Twelve 3-pdr. (?)
Torpedo tubes—						
Submerged	Two	Two.	Four.	Five.	Two (?)	Four.
Above-water	Three.	Two.	—	One.	—	—
I.H.P	17,475	16,200	18,000	16,000	19,000	20,000
Speed, knots	18	18	18.5	18	19	22
Screws	Three.	Three.	Two.	Three	Two.	Two.
Coal, normal	905	820	1000	700	900	1000
" maximum	1825	1150	2000	900	1900	2800
Plus	Oil.	Oil.	—	Oil.	—	Oil.

tables, the reason being that now-a-days the thickness of armor is about the same in all battleships, and differences in this direction are nearly negligible.

The artillery predominance of the *République* is here very marked, save against the *New Jersey*. If, however, we reduce all guns to the common denomination of the 12-pounder, we get the total fire values for one broadside as follows:—*New Jersey*, 99; *King Edward*, 78; *République*, 71; "*H* and *J*," 69; *Vittorio Emanuele*, 61; *Suffren*, 60.

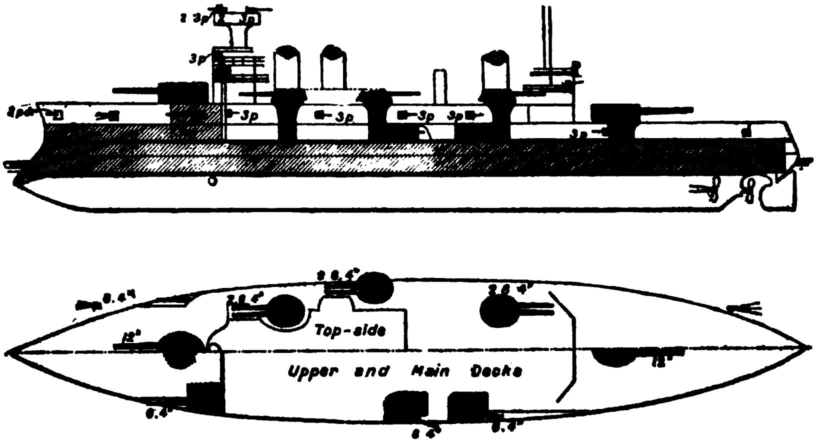
This, of course, makes the ships stand differently. It cannot be taken as absolutely representing their relative gun powers, because it ignores the penetration factor altogether, and this, though perhaps correct enough in the main, is still not to be ignored in the case of the *King Edward's* 9.2's, or the 8-inch pieces of the American and Italian ships. The 9.2's in particular give the *King Edward* a power against medium armor that the other ships do not possess, save, maybe, on paper. Still the comparison is approximately fair enough to help us to assess the relative values of the ships more surely than we may hope to do by merely putting down the guns themselves. And carrying on the principle we can, by dividing the displacements into these figures, place the values of the ships in gunfires per thousand tons of displacement as follows:—*New Jersey*, 6.5; "*H* and *J*," 5.2; *Vittorio Emanuele*, 4.8; *King Edward*, 4.7; *République*, 4.7; *Suffren*, 4.7.

This result is interesting as indicating how nearly all the naval architects arrive at the same result. The German's advantage is obviously paid for in coal; that of the American is not so easily traced, but we may be certain that it exists. American naval architects are compelled to design to "whip creation." Any Congressman from some inland State is able to criticize and help to throw out any design that does not appeal to him as whipping creation, and we shall have to wait for a big war to find out whether the peculiar conditions under which the amateur sets the pace in American designs are good or bad for naval architecture. Till then American ships must be things apart, so far as paper comparisons are concerned; compare them by whatever system we may select, they will always come out at the head of the list.

To return to the *République*. A change has come over the French system of armor disposition. In the *République* the *Suffren* ideal is faithfully adhered to, save that the armored battery is abandoned. It is replaced by six casemates, practically replicas of those that are to be found in most British ships, and which have just been discarded in favor of continuous batteries. In practice we fancy that the French are probably wise in giving up the continuous battery that at one time was to have characterized the *République*, for such batteries, failing the immense space available in our *King Edwards*, offer a terribly large area to big armor-piercing projectiles. From this danger the casemate system is singularly free, and even if a big projectile miss a casemate on one side, it is tolerably sure to hit one on the other side of the ship; still, the damage is extremely curtailed. Once inside an armored battery, the big projectile, lacking energy enough to get out, is likely to rebound from side to side, destroying everything, till there is nothing left to smash up. Certainly, this must occur in a crowded battery, and we are very sceptical as to the value of the thin screens usually placed in such batteries to localize hits that get through the outer armored wall.

The main water-line protection of the *République* consists of the complete belt 11 inches thick amidships, and 7 inches at the ends. At the extreme stern the two ends of the belt are joined by a short bulkhead. At the lower edge of the belt there is a flat splinter deck 3¼ inches thick. Above the main belt, and protecting the lower deck side, is a second belt 10 inches thick amidships and 5½ inches at the extremities. This is surmounted by a second armored deck, flat like the other, and 2¼ inches thick. Almost the entire space between is filled with coal, and, as will at once be seen, the total protection to the vitals is of a very high order.

The main deck forward carries 3¼ inch plating, 7½ feet high, that extends from the ram to just abaft the base of the fore turret. This affords some protection to the holing effect of small projecttles, and to that extent ensures that even in a heavy head sea the risk of lost speed from water thus admitted shall be slight. It also protects the two above-water training tubes here carried. Finally, it safeguards the base of the forward pair of casemates.



FRENCH BATTLESHIP REPUBLIQUE

On the main deck stand the two other pairs of casemates. Their thickness is 6½ inches on the fronts. On the upper deck, in addition to the forward pair of casemates, the after big gun turret is carried. This turret is 11 inches thick, and has the usual French armored base.

On the top side are six turrets, carrying the remaining twelve 6.4-inch guns. This coupling of the secondary guns in pairs is a feature of all modern French designs, and perhaps the weak point of the ship, though, no doubt, the huge secondary armament carried necessitates some such device. The French seem wedded to the twin-gun system, but in this country the prejudice against it is heavy. Not only is it doubtful that a full rate of fire can be maintained, but also a single shell hitting the turret is likely to put two guns out of action, and these defects are held to outweigh the certain obvious advantages of which so much is heard. It will be noted that one of these is that the maximum protection is given for the minimum of weight, so far as armor is concerned. The trouble is that, as we have so often pointed out, armor in itself does not confer immunity.

The forward big gun turret is carried on the same level as the secondary turrets, and the gun muzzles are fully 33 feet above the water-line, perhaps more. This is a good deal higher than those of the *King Edward*. The blast of these guns will certainly interfere badly with the forward casemate, if not with the forward torpedo tubes. Still, since the ship seems to fight chiefly against an enemy astern, this defect need not be overestimated.

The various fires of the ship are as follows:—Broadside, four 12-inch, nine 6.4-inch; right ahead, two 12-inch, six 6.4-inch; right astern, two 12-inch, seven or eight 6.4-inch possible; bow, two 12-inch, seven 6.4-inch; quarter, two 12-inch, eight 6.4-inch. The arcs of fire are:—Big guns, 270 degrees; casemates, 110 degrees from axial line; small turrets, 180 degrees from axial line; submerged tubes, 25 degrees fixed, abaft the beam; forward tubes, 45 degrees from broadside to bow; stern tube, fixed in axial line. The above-water tubes are carried higher than usual, being about 9 feet above the water-line. The ship is to carry six searchlights—one on the fore-top, one on top of the after-bridge, two on the main deck in the stern, and two under the forecastle forward.

The two belts have a combined width of 13½ feet, of which 5 feet are below water. The main-deck guns are about 12 feet above water. The forward casemate guns are 20 feet up, those guns in the small turrets are some 30 feet.

Four of the 3-pounders are carried on the bridges, the rest are disposed between decks.

—*The Engineer*, September 12, 1902.

The Belleisle Experiments of 1902.

Last year the *Belleisle* was the subject of experiment to test the effect of modern shell fire on personnel and material. She carried coal, boats, stores, and dummies representing personnel at different stations, and was subjected to nine minutes' fire from a first-class battleship.

The supposed particular object of the foregoing experiment was to determine the effect of gun fire on woodwork. From the havoc wrought by this fire, the lesson of the *Belleisle* appeared to be that the efficiency of the personnel in rapidity and accuracy of fire is of first importance and will be the principal factor in the result; that naval battles of the future will be short engagements; and that the first accurate shot will greatly influence results. There also appeared the necessity for a greater distribution of armor, more protection for the ends of the vessels and for the personnel at the guns. The terrible concussion of lyddite and kindred high explosives seemed clearly demonstrated, as was the fact that batteries must be protected against the bursting of such shell inside their casemates.

This year's tests were for the purpose of ascertaining the resistance presented by the sides and decks of the newest armored cruisers of the British navy, as well as the value of explosives, high and otherwise, as bursting charges in armor-piercing projectiles. To this end the hulk of the *Belleisle* was specially prepared. The account of the experiments that has become public is very meager, the greatest effort to attain secrecy having been exerted by the Admiralty. Launches and torpedo boats patrolled the harbor, while coast guardsmen cleared prominent shore points of all observers. After the firing, screens were hung over the armor plates, and, during certain examinations by higher officials, even commissioned officers not directly concerned with the experiments were not allowed to come near the hulk at the dock, while special policemen turned their backs during the process of photographing the injured plates. Later, owing to the difficulty of maintaining the secrecy desired, the *Belleisle* was towed away from the dock and anchored offshore.

Under these conditions little information has been available, and the following meager account is from the reports of various English papers:

Preparation of hulk.—The forward end of the *Belleisle* was fitted up to represent a 20-foot section of an armored cruiser, the starboard side representing the *Drake* (14,100 tons) class, while the port side represented the cruisers of the *Monmouth* (9,800 tons) or *county* class.

For this purpose a 4-inch armor plate was built into the hull on the port side forward, similar to those supplied for the side armor of the *county* class of cruisers, while on the starboard side were 6-inch plates identical with those ordered for the *Drake* class. These plates were made by Messrs. Campbell & Co., of Sheffield, the principal feature of the plates being that they had been only partially "Krupped" in order to ascertain the elasticity and resistance of a plate under these conditions. Each of these sections of targets on the hull was painted in black and white squares, there being an area of 20 square feet for each target. In the center of each plate was a "bull's-eye," and also a small cross to indicate the junction of the angle irons of the ship with the armor plates. The upper deck in the vicinity of the target was covered with 2-inch steel plates, the remainder of the deck being, as it always had been, wood. The interior of the vessel near the target was fitted as sections of the *Monmouth* and *Drake*, with coal bunkers just inside of the armor, transverse bulkheads, mess deck, and all internal arrangements of that part of a cruiser.

The attack.—The attack was made by the gunboats *Pincher* and *Comet*, the former mounting a 9.2-inch gun, the latter a 6-inch gun, both guns being of the latest models fitted with telescopic sights. The 6-inch plate was attacked by the 9.2-inch gun while the 4-inch was attacked by the 6-inch gun.

A new form of lyddite, as well as armor-piercing projectiles and common shells were used. Lyddite shells were fired from the 9.2-inch gun.

The *Belleisle* was moored about a mile out, broadside to shore, while the gunboats were some 700 or 800 yards distant, placed so as to fire out to sea.

Firing was opened by the *Pincher's* 9.2-inch gun at the 6-inch plate. Two rounds were discharged, and then two with the 6-inch gun of the *Comet*.

Afterwards, the *Belleisle* was swung around and the 4-inch plates attacked by two rounds from the 9.2-inch gun, and then by four rounds from the 6-inch gun, making in all ten shots. Between each two rounds, the Admiralty party visited the ship and made careful observations of the results, taking photographs of the effect of each shot on the plate.

Sixteen shots were to have been fired, but owing to injuries from the attack, due to one shot penetrating between "wind and water," and causing the ship to leak seriously, the trials were discontinued and the *Belleisle* was towed back to Portsmouth. Use of collision mats and steam pumps enabled her to be kept afloat.

Results of the attack.—Two of the 4-inch plates, representing the *Monmouth* class, were completely perforated, and one of the 6-inch plates, representing the *Drake* class, was also pierced, the 9.2-inch armor-piercing projectile going through the 6-inch plate and the 6-inch projectile through the 4-inch plate.

In each case an armor-piercing projectile got through, the common shell having broken up harmlessly against the plates.

The lyddite shell likewise failed to crash through, but the formidable shower of splinters which each lyddite-filled projectile threw out as it burst, showed that this shell would have a terribly destructive effect when fired at unarmored ships.

Some remarkable results followed the explosion of the lyddite shell. The *Pincher* fired these shells at 300 yards while the *Comet* was 2,000 yards away, abeam of the *Belleisle;* yet on the shell exploding on the side of the hulk, fragments rebounded and fell on the deck of the *Pincher* to the rear, and were also scattered near the *Comet*. Some of the fragments falling on the deck of the *Pincher* were less than two ounces in weight, and few weighed more than eight ounces, but all were heavy enough to do injury had they struck the men on deck.

English accounts give the following as the results of the experiment:

1. Four-inch armor, especially prepared, was penetrated by 6-inch shot, the shot much disturbing the coal protection, but doing little real damage.
2. The 9.2-inch lyddite shells were not effective against thin armor.
3. A 6-inch plate resisted 6-inch shot.
4. The minimum safe range, of the firing vessel, for firing lyddite is 2,000 yards.
5. Until a ship has been riddled by armor-piercing projectiles, lyddite is is useless, unless exploded inboard on deck.

Some comment was made upon the fact that the conditions of the test were in every way opposed to the conditions of warfare.

—*Notes on Naval Progress*, July, 1902.

MISCELLANEA.

A shell of a new type has been introduced into the German army and is stated to be receiving the attention of the British war office. By the introduction of a cartridge composed of amorphous phosphorus into the ordinary charge of smokeless powder a thick, white smoke is emitted when the shell bursts, thus showing the gunners, even at the greatest distance, how close the projectile has gone to the enemy's position. By increasing the proportion of this chemical, an operation which does not lessen the bursting effect, it is possible to deposit in front of the enemy's position a thick bank of white smoke which will obliterate his view of the field. Experiments with this shell are said to have proven highly satisfactory.

It is further stated that the Germans, with a view to the more efficient control of the fire of the various guns on board ship, are experimenting with smoke-producing compound for projectiles of the main and secondary battery.

Each caliber of the larger guns is to have its shell contain, in addition to the bursting charge, a smoke-producing compound which will produce a different color for each general type of gun.

—*Notes on Naval Progress*, July, 1902.

The most interesting event during the year in connection with projectiles is the development by the Firth-Sterling Steel Company of a new type of shell combining the advantages of the armor-piercing with the common shell; that is, having the perforating power of the regular armor-piercing projectiles with the capacity for a large bursting charge. The requirements for these shell on test are that at a prescribed velocity they shall completely perforate, unbroken, a plate of hard-faced armor a calibre in thickness and then be in condition for effective bursting. A number of shell of this description have been manufactured, and the first three lots have successfully passed the requirements. These shell are fitted with soft caps.

—*Report Chief of Bureau of Ordnance.*

In a recent number of our excellent contemporary *Mexico Militar*, there is an interesting article dealing with the inventions of Colonel Mondragon. As a result of his studies he has succeeded in transforming the gun at present in use in the Mexican field artillery, a Bange 2.95-inch, from a slow into a quick firer. The strength of recoil led formerly to the necessity for relaying the gun. The principal change made is in the carriage, the cradle on which the gun is mounted having its backward movement controlled by a new kind of hydraulic brake, with the addition of a strong spring, used to bring the gun back to its initial position after firing. After three rounds had been expended on correctly laying the gun, a speed of nineteen (19) rounds per minute was attained, and once twenty-two (22) rounds was touched. The gun is loaded in three movements. The estimated cost of alterations to the existing types is about one-tenth the cost of new guns, and all the work will be carried out in Mexico under the supervision of the inventor.

A novel experiment has been made at Aldershot, whereby guns have been rendered almost invisible at a little distance. By an ingenious scheme of painting the guns and limbers rainbow fashion with the three primary colors—red, blue and yellow—they have been found to harmonize with any sort of ground or background so admirably that at small distances they are difficult to locate. Six guns so painted were located on the Fox Hills, and the artillery officers at Aldershot were invited to try and discover them at about three thousand yards with field glasses, and although all knew the direction in which they lay, no one was able to pick them all up.

—*Engineer*, October 10, 1902.

The contract made by the Danish Government with the firm of Krupp provides that the new Danish field artillery shall consist of one hundred and twenty-eight 7.5 centimetre guns, firing projectiles weighing 6.5 kilogrammes. The guns are to be furnished with recoil brakes, and to fire from sixteen to twenty shots per minute. The gunners are to be protected from shrapnel fire by an armor-shield. —*Army and Navy Gazette*, October 18, 1902.

We read in the *Armée et Marine* that the new French field gun, during firing practice at the polygon of Songé (near Bordeaux) on sandy ground, failed entirely to realize the advantages of absence of any derangement in or loss of aim, on which such great stress is laid in the long recoil system.

The trail buried itself deeper and deeper after each shot and the piece finally reared up, causing disorder and confusion in the battery.

A new pontoon bridge has been used by the French in the military maneuvers this year in the Departments of Loiret and Vilaine. According to the *Matin*, in the Department of Loiret a bridge about 28 inches wide was thrown over the river Loire, the horses being made to swim while the drivers carried the harness over the bridge. The bridge was then converted into a sort of raft 8 feet in width, and the artillery was ferried across the river. The pontoons are very light and practically unbreakable. The bridge can be put together in twenty minutes, and taken apart in ten minutes. In the second case the bridge was thrown across the river Vilaine, 190 feet in width, in forty-five minutes, and battalions of infantry 1400 strong, with arms and baggage, crossed the river in forty minutes.

—*Engineer*, October 10, 1902.

The *Bayerische Militärzeitung* has recently published an article in which the author has calculated from official documents the number of trained men that Germany can raise in case of war. The 25 classes from 1876 to 1901 have furnished the army 4,983,103 trained men and 200,000 one-year volunteers, or a total of 5,183,103 men. With an allowable decrease of 20 per cent there remain in round numbers four million instructed soldiers available for war. There would also be 100,000 men, untrained but capable of being employed as workmen. If there are also included the reserve recruitment or first levy of the Landsturm, which are partially trained, plus the men of the classes of 1902, 1903, 1904 and 1905 (which would be called out in time of war) there will be obtained 7,600,000 men ; and with a decrease of even 50 per cent for this number, there yet remain 3,800,000 available men.

As a result, Germany could put in line immediately on the outbreak of war, in round numbers, four million trained men and, at the end of a few weeks, at least three million more, or a total of seven million men.

For the navy, the 25 classes, with the addition of 25 classes each of 500 one-year volunteers, and allowing for a decrease of 25 per cent, furnish 112,000 instructed sailors.

The number of non-trained sailors, but susceptible of receiving sufficient instruction in a relatively short time, would be 33,000, allowing for a decrease of 40 per cent.

In case of a war on land and sea, Germany could, therefore, make use of, in round numbers, eight million men.

The German paper adds that the last census, December 1, 1900, shows that 10,712,483 men, between 17 and 45 years of age, are domiciled in the German Empire. Adding to this those in the colonies, on board ship in ports at home and abroad, there is obtained a total of eleven million individuals bound to military service.

BOOK REVIEWS.

The Times History of The War in South Africa, 1899-1901. Edited by L. S. Amery. Vol. II. Imported by Charles Scribner's Sons, New York. Price $30.00 net for the 6 volumes. Sold only in sets. Two volumes now ready.

The second of the six volumes of this comprehensive and splendid work on the recent Boer War has been issued, a work such as is rarely obtainable, because it is the consensus of the best military opinion available, presenting the political, strategical and tactical features of a great war in the light of the most intelligent participants, discussing the entire subject in a fair but critical spirit, supplemented by the views of non-combatants of the highest standing, and furnishing a picture that will be a lasting monument to British military ability and the deeds of a great army.

The first volume of this work traced the political causes of the South African War from the British acquisition of Cape Colony down to the ultimatum presented by the Transvaal on October 9, 1899; the present volume contains a description of the historical development, organization and characteristics of the two military systems, the British and the Boer, the preparation for war on both sides, and a narrative of the military operations to include the battle of Colenso.

A large part of this second volume is therefore devoted to the description of a period of only about three months, but it must be remembered that the first months of this war had an intense dramatic interest as well as a great military significance, and therefore deserved extended description as well as minuteness of detail.

The style of the work is critical but not prejudiced, and the author has made every endeavor to present a fair, unbiassed account, calling upon all ranks of the British army for assistance in obtaining accuracy, and receiving help from burghers of the Boer Republic (who took part in the war) for data relating to their side of the great contest.

The chapter on the British military system is exceedingly interesting, and the discussion of the defects of this system has many important lessons for our own system.

The two great requirements are the education of the officers and decentralization. Comparing the British and Prussian systems the author says: "The secret of Prussian success lay in the absolute supremacy assigned to intellectual ability throughout the army—a supremacy which found its highest expression in the great general staff whose business was to think out in peace every possible contingency of war; in a completely decentralized organization by which every military district was to all intents and purposes a separate army."

The Boer military system is presented in a clear light, and in addition a discussion of their tactics brings to light the causes of the many surprises experienced by the British, their use of rifle fire and intrenchments, their mobility and individual initiative and the difficulty of discovering the strength of their forces.

Although the possibility of war was realized in June, 1899, and Lord Wolseley urged mobilization then, the government was opposed, because such action might be construed into a policy of menace. The British forces in Natal and Cape Colony were consequently entirely inadequate at the outbreak of war; and the difficulties of the situation resulting are fully presented in connection with the preparations for war in a separate chapter that explains many points not clearly understood at the time, especially, the failure of White to concentrate at Ladysmith and the determination to hold on to isolated points like Dundee, Kimberley and Mafeking.

The accounts of the operations from Talana to Colenso are graphic and intensely aborbing, besides being highly instructive. In the just criticisms passed on commanding officers, none are spared, consequently the entire story is rich in lessons for military students. The strategical mistake of White in holding on to the advanced position at Dundee, his tactical mistakes in the distribution of his forces, General Symons' over-confidenc and neglect of precautions, the incompetence of Meyer, and the failure of Erasmus to cooperate, are all treated with the same calm, intelligent, even-handed criticism, in the first important action of the war at Talana. So through the actions Elandslaagte, Rietfontein and finally Ladysmith.

The campaign in the west is next taken up, and here the deficiency in cavalry is the prominent element at the start, and accounts for much that was unaccountable at the time, especially for Methuen's lack of information in regard to Cronje's position at Modder River, which caused him to make his injudicious attack as he did. It appears that Methuen had no intention of making the purely frontal attack which was made, but was deceived as to the lay of the land and the course of the river (due to imperfect maps) and as to the strength and position of the enemy due to poor and insufficient cavalry. But for the lack of direction in the battle, so that no orders reached either brigade for the greater part of the day, which was largely brought about by Methuen's presence in the fighting line instead of at his nominal headquarters, he is severely and justly criticised.

The events in the south-central theatre are represented by the lamentable failure of Gatacre at Stormberg, the chapter devoted to which is largely from the pen of Major A. W. A. Pollock, an able tactician and military student, who participated in this affair.

The volume closes with the stories of Magersfontein and Colenso, representing the culmination of the British mistakes and disasters. Methuen's complete inactivity, and his lack of information before the battle, the surprise of Wauchope's brigade while deploying, and Methuen's failure to support the Highlanders during the attack, are the main subjects for criticism in the first of these battles, although the defects in the plan of action, the night attack and the purely frontal character of the attack in general are also severely dealt with.

The story of Colenso holds the reader's attention from beginning to end, and here again many previously misunderstood events are fully explained. One of the first is the fact that Dundonald's reconnaissance of November 28th, and the subsequent ones were made over ground in front of Colenso and added nothing in the way of information; none were made against the flanks of the Boer position. Hence the ignorance of the British as to the true situation. Buller was preparing to attack in flank by way of the upper Tugela, but the lack of transportation and Methuen's defeat at Magersfontein decided him to make a frontal attack at Colenso. The lack of cooperation, by a strong attack in rear of the Boer line, from besieged Ladysmith is now explained by the fact that White (in command there) was not informed of Buller's proposed advance. Colonel Long's loss of the field guns by his reckless advance a mile and a half ahead of the infantry, was due to a theory which had been growing up among some artillerists in favor of pushing guns forward and securing an overwhelming short range fire as quickly as possible.

Speaking of Colenso, the author sums up in this wise; "Buller's men had not failed him, nor would they have failed him then whatever he had asked of them. But it was the general, who, at the critical moment, failed his troops. Already before the battle his purpose and his spirits seem to have wavered more than once, and under the stress of temporary failure, his judgment and nerve alike forsook him."

The character of the entire work is such as to make it unquestionably authoritive for the future, quite as much so as the official Records of the Rebellion or the German official General Staff account of the War of 1870-71, and as a study in strategy or tactics it is far more useful than either.

The volumes are well printed and tastefully bound, while the maps and illustrations are excellent. J.P.W.

Le Paysage Militaire. Emploi du croquis panoramique en campagne et dans les reconnaissances. Par le Lieutenant Lefebvre du 4e Régiment d' infanterie. Paris: R. Chapelot et Cie. 1901. Pp. 46. O.

This pamphlet, published last autumn, is the most complete and best practical work on the art of military landscape sketching that we have read.

The subject is one of prime importance to the officer in the field. Of late more and more interest is being developed in the art, and the military press in several countries has recently been devoting attention to it.

As a rule this particular subject has been treated as a part of or constitutes a chapter in the general subject of military sketching, and we have seen many such works in which the value and importance of this art are discussed and general principles enunciated, with some examples added for illustration; but for a detailed and *practical* method for learning the steps, for training the eye and hand in studying and reproducing the features of the ground for military purposes, we have seen nothing that quite compares with this book.

As the author modestly states, his work is far from being a complete treatise on military panoramic art. It is simply a collection of practical hints and suggestions for the use of officers and all who may be interested in the art, to assist them in exercising their talents in this line, to their great advantage in regard to their military education, and to enable them in the field, as in a reconnaissance for example, to bring back useful sketches showing the ground that they may have studied and traversed.

The author devotes a few pages to the importance and great value of a landscape sketch; its advantages over and why it is to be preferred to a photograph; and then proceeds to the general outline of the method to be followed, giving the essential characteristics of such a sketch, rules for perspective and the order to be observed in learning the mode of execution.

He next takes up in detail the preliminary exercises in training the hand. In this are included all the natural and artificial features of the ground and the manner of representing them quickly yet accurately.

A good point is made here of dividing the landscape into three distinct distances, objects and features in each being always represented by a certain weight of line; firm, from 0 to 500 metres; medium, from 500 to 1000, and fine, those beyond 1000 metres. In this way there is obtained, with the corresponding sizes of objects represented, a scale of three planes which suffices, in the majority of cases, to give to the drawing a sense of distance and aerial perspective easily obtained without having recourse to shading which is to be avoided when one works rapidly because it represents a loss of time, generally soils the sketch and thus makes it lose its crispness and clearness.

Buildings, trees, forests, rocks, fields, roads, water, rivers, etc., and the representation of hill forms, etc., by curving lines and perspective hachures are all illustrated and the correct manner of drawing them explained for quick, crisp work.

The training of the eye is similarly treated. Practical problems are considered and from what is actually *seen*, the proper deductions are drawn and the landscape can then be correctly delineated.

To illustrate the principles thus set forth, the complete theoretical execution of a panoramic sketch is then given, the sketch representing a certain portion of mapped ground given in the text. All the details connected therewith: examination of the *terrain*, its tactical value, limits of the sketch, choice of the point of view, work of execution in its various stages, legend, remarks and inking—are carefully considered and useful hints given under each.

The application of panoramic sketches in field service, including some useful notes on rapid field sketching, *croquis-minute*, and colored sketches by wash or crayon forms the concluding chapter.

All through the book the matter is presented in a simple, direct and practical manner and we cannot too highly recommend the book to all who wish to perfect themselves in this important part of their military education.

The text is supplemented by 33 figures which fully illustrate the points discussed. These little sketches possess indisputable artistic value and can well serve as good models for practice in training the hand. H.Jr.

Taktisches Handbuch von Wirth, Hauptmann im 15. Königlich Sächsischen Infanterie-Regiment Nr. 181. With tables, diagrams, 1 sketch and index. 4th enlarged edition. Berlin: Verlag der Liebelschen Buchhandlung. 1902. Pp. xix+308.T. Marks 2.50.

This is the fourth edition of this excellent handbook of field orders, tactics, marches and administration. It is intended primarily as a handbook, a pocket reference book to be constantly consulted for details in the subjects it covers.

The first section refers to *orders* given to troops in the field; their general character, the details that are essential, especially the official forms, the context and best mode of stating the subject matter; to *reports*, what they should contain; and to *methods of transmission* of orders or reports, by mounted orderly, by cyclist, by telegraph or by telephone.

The second section comprises *marches;* the orders issued, their object and the roads to be taken, the time of breaking camp, the duration of a march, distances between subdivisions, depths of various columns on the march, means of preserving the troops in good condition, orders of march of various subdivisions, advance guards, rear guards, heavy artillery, train and ammunition columns, and the service of security and information.

The third section relates to camps, cantonments and bivouacs, including the supply of troops, the ration, hygiene, and outposts.

The fourth section relates to orders given preparatory for delivering battle, including a description of the battle formations of the different arms of the service, a table of the times required to deploy columns of various composition, and the tactical principles of defensive and offensive battles and retreats.

Finally, the fifth section considers the general principles of the tactics of the separate arms in detail.

The book, as now presented, includes the latest regulations of the German army, and is useful, instructive, reliable and interesting. The new matter (new since the edition of 1900) is that relating to night marches, the use of mountain batteries, machine-gun detachments, balloon sections, the conduct of patrols, the construction of pontoon and folding-boat bridges, the method of swimming troops over a stream, effects of infantry and field artillery fire and a list of the most useful charts and maps published by and relating to the countries of Europe.

There is hardly a page in this little book that will not be found valuable in the field to officers of any army, and which will not be worthy of careful study in time of peace. In Germany it is regarded as one of the most generally useful handbooks for the army, especially in maneuvers and in campaign.

J.P.W.

On Outpost Duty: What to do and how to do it. With hints on Reports, Reconnaissance and Scouting. London: Gale and Polden, Ltd. 1902. Pp. viii+147. T,. Sixpence.

In this little book has been compiled a great deal of very useful information in accordance with the English combined training 1902. In the preface the compiler states that the chief aim has been to embody the very essence of outpost work, in the clearest and simplest manner, in a handy-sized form and easy for reference at any time.

He has certainly succeeded in setting forth all the principles and rules to be observed in everything connected with outpost duty clearly and in a simple, practical manner. In addition, there are many instructive hints and rules given that are of constant application in all good reconnaissance and scouting.

The book is well adapted to be carried in the pocket, and the matter it contains will always be found useful either in the field, camp or quarters.

We may assert that the officer or soldier who makes himself thoroughly conversant with rules, duties and data here set forth has practically absorbed the essence of outpost duty.

H.Jr.

Einfluss der Schilde auf die Entwickelung des Feldartilleriematerials und der Taktik. Von v. Reichenau, Generalleutnant z. D. 1902. Vossiche Buchhandlung: Berlin, W. 50, Ansbacherstr. 9. Pp. 62. O. Marks 1.60.

Ergaenzung zu Einfluss der Schilde: Versuchs-Ergebnisse. Von v. Reichenau, Generalleutnant z. D. 1902. Berlin. Pp. 82. O, with photographs. Marks 2.25.

Lieutenant-General von Reichenau's study has already become the property of the military world, and to a great extent of the general public, through articles in the daily press. The article in question was of such a character that it at once answered, in most minds, the question of *shields* for field artillery, and the treatment of the entire subject was so thorough that it practically settled the matter in the minds of many.

In the domain of field artillery a great change is in progress, which like all great changes in weapons, affects the *tactics* in use, and in this case the tactics of *all* arms are more or less involved. The cause of this change is the adoption of the modern rapid-fire field piece *with shields*. Now that France has made the change of armament in her army, no state of any importance can avoid the question : It is no longer a question whether or not the new material shall be adopted, but merely *how* the change shall be made. The essays before us aim to clear up this question.

In the first one the author traces the origin and development of the idea of affording protection by shields, discusses the advantages attributed to shields, analyses the causes which led to the conversion of the recent shrapnel-firing field piece into a shell-firing gun capable of destroying shield armor and of the shrapnel-firing howitzer into a shell-firing one, and considers the changes required in the caissons and limbers to meet these altered conditions of gun and howitzer.

The essay closes with a very masterly discussion of the changes in tactics resulting from this radical change of material.

The second pamphlet contains the results of actual firing against field pieces with shields, against lines of skirmishers, walls, etc., using the new material, and closes with the deductions to be drawn therefrom.

The entire work is an exhaustive study of the subject, so complete as to leave nothing to be desired. It is a logical presentation and a full summary of our present knowledge of the subject, and the conclusion can only be altered by further developments in material, or by more extended experiments.

The essays have been decisive in Europe as to the necessity for the proposed changes, and also as to the manner of making them, and may be regarded as representing the highest military opinion of the day.

J.P.W.

The Gunner's Catechism. A Series of Questions and Answers in Untechnical Language for the Use of all Artillerymen who desire to become either First or Second-class Gunners. Compiled by Captain William R. Hamilton, Artillery Corps, U. S. A., Assisted by Lieutenant Paul Stanley Bond, Engineer Corps, U. S. A. New York: John Wiley & Sons. 1902. Pp. x+163. T. Red Cloth. $1.00.

The object and scope of this little book is well set forth in its descriptive sub-title. The authors make no attempt to write a technical book on Gunnery, but their aim is rather to furnish a useful manual for enlisted men ambitious to become gunners, and for the use of all.those beginning the science.

With this object in view they have drawn freely from the pamphlets and manuals issued by the War Department, those issued by the Artillery School and, in addition, from the service manuals and well-known standard works. They have compiled the matter obtained from these sources and have arranged it under the heads laid down in the examination for gunners, with the endeavor to express it in terms that will be readily understood and as far as possible in language that is devoid of technicalities.

The question-and-answer system appeals as a rule to the enlisted man for each question presents a concrete definite idea on one point, but, for that very reason, it is open to the objection that unless the questions are very complete and judiciously framed, there are apt to be omissions, and information sought may not appear under any of the questions propounded. Also due to the nature of the questions asked, although the point of view of the author may be brought out, the question might well be answered otherwise, and the given answer may convey information of little practical value.

We notice a good many instances of these faults in the present book. Moreover untechnical language need not necessarily be inaccurate language, and we find inaccuracies and statements that will surely convey incorrect information and therefore should be corrected.

"How are angles measured?" is a very general question and can be answered in several ways, but the author has in mind degrees, minutes, etc., so the answer is given "*by* divisions termed degrees, minutes and seconds," which is hardly accurate to say the least.

We think "sights" would rarely be considered one of the angle-measuring instruments more commonly used in gunnery.

In defining "horizontal," it is stated "horizontal means perpendicular to the direction of gravity, or the direction in which objects fall at the point considered." This is evidently not intended. This same question and part of the answer are repeated on page 47, and there the meaning is more clearly expressed.

The *principle* upon which a vernier is constructed is said to be "that the entire length of the vernier scale is equal to a certain number of divisions of the limb or main scale." This, we think, would convey to any one very little idea of the true principle upon which the construction of a vernier is based.

The author states that the cups of the anemometer should be placed "at the mean height of the trajectory." What is meant by this exactly we fail to see. Take the 12-inch B.L.R., for example, M. V. 2025 f.s.; the mean height of the trajectory may be any height from 6.4 feet at 1000 yards to 844 feet at 9000 yards, depending on the range at which the gun is fired. Naturally, for any other gun it would be a different height.

Further on the question is asked, "describe the aneroid barometer." Answer: "It consists of a box from which the air has been exhausted. The changes in the pressure of the atmosphere change the shape of the box, and these changes move a pointer which indicate the corresponding pressure of the atmosphere."!

Throughout the nomenclature of guns, carriages, etc., we notice omissions of names of many parts. They may not be what the authors call principal parts, in all cases, but they are important and their names and purpose should be given. Nor is any mention made of the U. S. spring-return mortar carriage, model 1896. In this connection, it would be well to give the model of all the various instruments, guns and carriages, etc., described here and elsewhere in the text and in that way prevent any confusion or misunderstanding.

Nothing is said about zones of mortar fire or weights of various charges used. Under projectiles we find, "solid shot are for attacking armor, and since an entirely solid shot is subject to initial strains when cast or forged, they are made with a cavity or core, and are called cored shot." This, besides containing an incorrect statement, would certainly give a beginner a very confused idea of solid shot and cored shot.

It is also stated: "For the 12-inch steel mortar the weight of the projectile is 1000 lbs., and for the cast-iron mortar it is 800 lbs."

We quote these instances at random through the book simply to show how, in some cases, the matter could be presented in a better manner, and to point out some of the omissions and inaccuracies of expression that could well be avoided.

It is an evil of our service at present that want of uniformity in nomenclature obtains in many cases as regards artillery material and appliances. Though that adopted by the authors in the description of and questions on the Lewis range-finder has been used, it would have been better to have followed the nomenclature of Artillery Notes No. 3, in this particular, as this description (published by authority) is now in the hands of all artillery companies.

We regret also the lack of suitable illustration which would in many cases aid one greatly in following the descriptions and in fixing the principles in mind. Due to this lack, we doubt if the questions and answers on knots and cordage will be of use to those who have never made or seen the knots there described. The plate showing a difference chart is excellent and illustrates the point we make.

Parts of the book are extremely good, and we have no doubt that it will meet with favor throughout the service by those for whom it was intended. It is for this reason that careful revision is of importance.

On the whole, the book contains much useful information, in a convenient form, now only found in several separate books which may not be at all times readily accessible to the enlisted man. H. JR.

L'Etat Militaire des Principales Puissances Etrangères en 1902. Germany, Austro-Hungary, Belgium, Bulgaria, Spain, Great Britain, Italy, Roumania, Russia, Servia, Switzerland, Turkey. 8th Edition, enlarged. By J. Lauth, chef d'Escadrons de Cavalerie. Paris: Berger-Levrault & Cie. 1902. Pp. iv+1051. O. 7 fr. 50 c.

This book forms the eighth edition of this important and excellent work, one that to-day has become a classic which is to be found in all important military libraries, and is of great use to all those who wish to be fully informed on the forces and military organization of European Powers.

The idea of the work was first conceived by General Rau who published the first edition in 1877. Credit for its logical mode of arrangement is due to him and these systematic divisions for chapters under each country, an arrangement that has always given satisfaction, have been carefully preserved in all subsequent editions including the present one.

The necessity of giving in this way all the details of organization and other information on any service uniformly for each country has undoubtedly been considerable labor for the author, but such work is largely repaid by the great resulting advantages: With a classification of this kind no important omissions can occur; there can be readily set forth minute details of organization of each country, and the reader enjoys great facility for comparing the various systems of organization and consequently for understanding them and for more easily retaining their details.

The success of the seven preceding editions bear witness to the usefulness and value of this work. The incessant changes which take place in all armies soon make publications of this nature out of date, but in this case the development of the military forces of the Powers considered has been carefully followed and incorporated, new chapters have been added as necessity required, and this edition of 1902 may be said to fulfill all requirements in regard to giving exact information (as far as can be obtained) on all the armies of which it treats.

In it for the first time are to be found new chapters devoted to the armies of Bulgaria, Servia and Turkey; armies of which too little is usually known, but the real importance of which (secondary as they may be) it is well not to lose sight of, as they may become important factors in European politics.

Each country is treated under the following heads:

Chapter I.—Command in chief; central administration; General Staff of the army; budgets.

Chapter II.—Recruitment and reserves.
Chapter III.—Remounts and supply of horses.
Chapter IV.—Active corps and auxiliaries ; staff and administrative services.
Chapter V.—Organization of troops; infantry, cavalry, artillery, engineers, reserves, militia, etc.
Chapter VI.—Military divisions of the country and distribution of troops; defensive organization of territory.
Chapter VII.—Formation of the army in case of general mobilization.
Chapter VIII.—Wagons and convoys for a mobilized army corps. Supplies of ammunition, tools and provisions.
Chapter IX.—Armament and artillery material.
Chapter X.—Miscellaneous military establishments; schools, arsenals, camps of instruction, firing grounds, etc.
Chapter XI.—Colonial army.
Chapter XII.—Uniforms; insignia of rank. Flags.

The information has been gathered by officers of the staff of the French army and the book possesses the merit of exactness due to the care with which it has been compiled and revised.

The work has become thus a valuable book of reference, thanks to the abundant information it contains, and also one very interesting in continuous reading thanks to the order adopted and clearness obtained in presenting such a number of details. H.Jr.

The Private Soldier under Washington. By Charles Knowles Bolton. Charles Scribner's Sons. New York: 1902. Pp. xiii+258. O., with index. Illustrated. Blue Cloth. $1.25.

That our Colonial history affords an interesting field that is being more and more appreciated for serious research, as in the book before us, is well proved by the number of successful and excellent works that have treated of this period. Older writers have furnished a large amount of authoritative information and more recent ones, like Ford, Wilson, Lodge and others, by their studies on various periods and personages of the times have done much to arrange this material and to bring into evidence the value of early American historical documents.

This life of the private soldier of the Revolution is the latest to be included in the list, and it will undoubtedly meet with ready acceptance by the student and reader as well, both on account of the information it contains and the delightful style of the author in imparting it.

Mr. Bolton, while acknowledging the labors of those later writers who have done so much to make easier the way for others, goes first of all to the diaries and journals of the soldiers themselves and then to other contemporary documents both public and private in the endeavor to present the actual life of the men of Washington's army. As he states, "much has been written about the American Revolution, but our knowledge of the private soldiers of the patriot army is confined chiefly to Washington s description of their sufferings at Valley Forge. Their story is to be found in a line here and there scattered through the mass of contemporary literature."

The author has carefully sifted this material and, giving in every case the name of the authority who saw what he described, has constructed a straightforward narrative of the daily life of the private soldier who served in the Revolutionary War.

Commencing with the origin of the army, he graphically describes the events that led to the assembling of the forces and gives us much valuable, at the same time entertaining, information on the subsequent difficulties of regular organization and of equipping and maintaining a regular army.

"It was no light task to bring an army into the field and maintain it for years, combating successfully the local prejudices of northerner and southerner, the greed for bounties, the trials that follow a depreciating currency and an advance in the price of family necessities, the fear of militarism and the dislike of strict discipline in an age of democratic theories."

The author then treats more particularly of the conditions and incidents of the daily life of the soldier of those times: His material needs, clothing and subsistence; his equipment, firelock and powder, and training; the relation between officer and private; camp duties and camp diversions; the hospitals and prison-ships. Every page holds the reader's attention. In connection with the recent changes in our present uniform, it is interesting to read that "the general hue of the ranks * * * * can best be indicated by saying that the browns and greens predominated". Tow cloth which had been steeped in a tan vat until it became the color of a dry leaf was much used for parts of the uniform, especially the leggings. This "rifle dress" was in the minds of the British, associated with a skilful marksman and Washington urged its importance in these words: "It is a dress which is justly supposed to carry no small terror to the enemy who think every such person a complete marksman."

In the chapter devoted to the army in motion the author gives many graphic pictures of both the dark and bright side of the private's experiences on the march and in action; and finally in one of exceeding interest on the private himself we read of his characteristics, behavior in action, his opinions and mental traits and his failings.

The citation of authorities shows upon what a solid foundation the book rests; while the elasticity and charm of the author's style give color and atmosphere to the recital of the barest facts. Not the least interesting feature of the book are the excellent illustrations of old broadsides, historical documents, relics, etc., which supplement the text.

The publishers have done their part well, and in all respects the book is a capital one. We have no hesitation in saying that it will undoubtedly be an attractive addition to, and should be in the library of every one interested in our military history and military organization. H. Jr.

EXCHANGE AND BOOK NOTICES.

[Books received will be *reviewed* as space becomes available.]

Lectures on Explosives. A course of lectures prepared especially as a Manual and Guide in the Laboratory of the U. S. Artillery School. By Willoughby Walke, Captain, Artillery Corps, U. S. A. 3rd Edition, revised and enlarged. New York: John Wiley & Sons. 1902. Pp. xvi+435. O. Red Cloth, $4.00.

Notes on Fortification, with a synoptical Chart. By Major B. R. Ward, R. E. New York: E. P. Dutton & Company. London: John Murray. 1902. Pp. 50. Q. Red Cloth, Two Shillings.

La Défense de nos Côtes. By Cabart-Danneville, Député. Paris: Librairie Hachette et Cie. Pp. 402. D.

Aerial Navigation. A practical handbook on the construction of Dirigible Balloons, Aerostats, Aeroplanes and Aeromotors. By Frederick Walker, C. E.

New York: D. Van Nostrand Company. 1902. Pp. xvi+151. D. With about one hundred illustrations. Brown Cloth, $3.00.

Customs of the Service. The Army, National Guards and Volunteers. By Colonel James W. Powell, United States Army. Revised Edition. Kansas City, Mo.: The Hudson-Kimberly Publishing Co. 1902. Pp. xiii+285. S. Blue Cloth, $1.50.

Notes on Laying, Repairing, Operating and Testing Submarine Cables. U. S. Signal Corps. Prepared uuder the direction of Brigadier-General A. W. Greely, Chief Signal Officer, U. S. Army, by Captain Edgar Russel, Signal Corps. With supplementary chapter on Factory Testing, by Lieutenant-Colonel Samuel Reber, Military Secretary. Washington: Government Printing Office. 1902. Pp. 70. O.

The Anglo-Transvaal War. Notes of the Boer General Villebois de Mareille. Translation from the French. St. Petersburg: Commissioner of the Russian Military Educational Institutions. 1902. Pp. 149. O. Paper.

We have received and read with great interest **Notes on Naval Progress, 1902,** constituting No. XXI. of the General Information Series published by the Office of Naval Intelligence. This number forms a large volume of over 500 pages, with many illustrations, and includes a great many features of general naval and military interest which have been compiled since July, 1901.

We are indebted to this publication for several interesting items which appear in our Professional Notes.

The principal matters considered are:

Notes on ship and torpedo boats, including ships building abroad, steam trials, reconstructions, etc.

Ordnance and armor, giving some of the recent armor tests abroad, the development of guns and mounts and recent information on explosives, projectiles, torpedoes, etc.

Engineering Notes, a general review of Electrical Progress and an excellent summary on Wireless Telegraphy, all contain much valuable information.

Lieutenant Nulton, U. S. N., comprehensively treats of the Naval Maneuvers of 1901. The English are of special interest as being the most extensive yet held and as allowing the greatest freedom of action on the part of the commander-in-chief. The French also possess several points of interest: The system denoting the fighting value of ships, the reassignment of values to prevent the premature close of the maneuvers, the disposition of the enemy, and especially noteworthy the point that, as a French paper states, "our Navy is entering upon a new era of which the watchword is 'Attack' !"

The illustrations in this number are especially fine and add greatly to its interest and value.

Notes of Military Interest for 1901, published by the Military Information Division of the Adjutant General's Office, forms a volume of 549 pages containing a large amount of information on foreign services compiled from various reports, books, periodicals, etc., received in the Military Information Division during 1901.

These notes are on organization, field artillery, machine guns, small-caliber rifles, automatic pistols, explosives, ammunition supply, mechanical transportation, carrier pigeons, etc., and maneuvers. They are very complete and constitute an important addition to what may have been previously published on the subject considered. An valuable feature of the work is the bibliography of special military subjects treated by the foreign military press in 1901.

M. Cloarec writing in **Le Yacht**, of October 4, gives quite a complete account of the recent American combined maneuvers. He does not appear, however, very favorably impressed with the results obtained. After describing the various attacks, the inefficiency of the search light system, the results obtained with mortars, the mine defense, etc., and the results claimed by both sides, he sums up as follows:—"It appears that the conclusion to be drawn from these maneuvers is that the fleet and army have profited but little from the experience gained in Cuba, from the point of view of forming a just estimate of the powers of the force opposed to them. Each of the two parties considered that it had reduced the other to a condition of impotence. The forts appear to have fired recklessly without much consideration of probability of fire in reference to the special conditions of the moment, while the fleet regarded the fire of the batteries as a negligeable quantity. Errors also occurred in the selection of the objects of attack, and inoffensive steamers came under the fire of the batteries. Here then we find a new proof of the difficulty experienced by naval and military officers in coming to an agreement upon essential points. This difficulty occurs everywhere, and proves the necessity of bringing the land and sea forces into frequent contact, above all in connection with coast defense; but the difficulty would be diminished if this defense were entrusted to a special corps, amply provided with the necessary appliances afloat.

INDEX TO CURRENT MILITARY LITERATURE.

[For Abbreviations used in Index see first number of each *volume.*]

[All periodical are of 1902 unless otherwise indicated.]

ARTILLERY MATERIAL.

Ammunition supply.—**Mil. Information Div.,** January.

Projectiles to be used with R.F. guns of reduced calibre.—**A. Belge,** July-August.

The gun carriage tests, U. S.—**A. and N. Jour.,** September 20.

The most advantageous form of trail for non-recoil gun carriage.—**Notes on Const. of Ord. No. 83,** 1902.

Short description of improvised travelling carriage for 6-inch Q.F. guns.—**Proceedings R.A.I.,** June-July.

Disappearing carriages for guns above 5-inch calibre, U. S.—**A. and N. Jour.,** November 1.

Primer of the rudimentary principles of explosive substances and their manufacture.—**Mex. Mil.,** September 1; November 1.

Experiments with wet gun-cotton as bursting charges for shell.—**R. G. de Marina,** September.

Classes of powders and their application in war.—**M. de Art.,** August.

New explosive and smokeless powder, Italy.—**Mitth. Art. u. G.,** August, September.

A powerful explosive, "Schneiderite."—**R. M. Suisse,** August; **Art. Tids.,** September, October.

Notes on ordnance and armor, explosives.—**Naval Intelligence,** July.

Explosives.—**Mil. Information Div.,** January.

Hathamite, a new explosive.—**Scien. Amer.,** November 8.

Italian modern field artillery material.—**Die Armee,** July 25.

War material at the Dusseldorf exposition.—**Die Armee,** September 6; **Wochenblatt,** September 20, 24, October 1, 8, 15.

Material for tubes of field guns.—**Schweiz. Mil. Blatter,** August.

Krupp artillery material at Dusseldorf exposition.—**R. G. de Marina,** September; **R. Artig.,** July-August.

Guns at the Dusseldorf exposition.—**Stahl u Eisen,** October 1, 15.

The question of field artillery guns without recoil in Germany.—**A. Etrangeres,** March.

Guns and mounts.—**Naval Intelligence,** July.

Field and position artillery material from Schneider & Co., and experimental firing with same at Harfleur, March, 1901.—**Art. Tids,** September, October.

Premature explosions in quick-firing guns.—**A. and N. Gaz.,** September 27; **A. Belge,** July-August.

The use of coast howitzers.—**Art. Tids,** September, October.

A reliable tide-gauge.—**Eng.** Cleve. October 15.

French R.F. field artillery, its methods, etc.—**A. and N. Jour.,** September 20.

Recent development of field artillery material on the continent, Russia, Austria and other countries.—**Proceedings, R.A.I.,** June-July.

Artillery at the Dusseldorf exposition (shields and guns after firing tests).—**Int. Revue.,** Supplement 43.

Torpedo experiments, Spain.—**R. G. de Marina,** October.

The French field gun m/97 in the Chinese campaign.—**Die Armee,** August 22.

Test of field guns for the U. S. Army.—**A. and N. Reg.,** September 7.

The Italian 7.5-m/m field gun.—**Armee et Marine,** September 7.

French R.F. field artillery.—**A. and N. Jour.,** September 20.

An Italian and German opinion of the French R. F. field gun.—**R. Art.,** August, September.

Austro-Hungarian new 4''.15 field howitzers.—**A. and N. Gaz.,** September 13.

English artillery.—**Schweiz. Mil. Blatter,** August.

Krupp mountain gun, model 1901.—**R. M. Suisse,** August.

Experiments with defensive shields on field guns.—**Umschau,** September 27.

New gun for U. S. field artillery.—**A. and N. Jour.,** October 25.

Mortars of 24 cm., and 120 mm, Skoda system.—**R. Art.,** September.

Transformation of the Bange gun.—**Mex. Mil.,** September 1.

Field mortars, Austro-Hungary.—**M. de Art.,** August.

Field howitzers.—**Proc. R. A. I.,** June-July.

Field artillery abroad.—**Mil. Information Div.,** January.

The French field artillery material, C/97.—**Mitth. Art. u. G.,** October.

German machine guns.—**Mex. Mil.,** September 1.

Machine guns.—**Mil. Information Div.,** January.

Projectiles at present used in the French navy.—**Yacht,** August 30.

Recent trials against armor plate of cementation steel in England and America, with bursting shell, capped and uncapped, with the Gathmann projectiles.—**Genie C.,** August 30.

Notes on ordnance and armor, projectiles.—**Naval Intelligence,** July.

The Knobloch tachymeter for measuring angles and distances.—**R. M. Suisse,** July.

AUTOMOBILES, BICYCLES, AEROSTATION.

The Santos-Dumont and Severo balloons.—**R. Marit.,** Brazil, July.

Applications of paper-kites.—**Exercito,** August.

The Stevens airship.—**Scien. Amer.,** October 4.

Firing at a captive balloon on Salisbury Plain.—**U. S. Gaz.,** September 27.

The Spencer airship and its 30 mile trip.—**Scien. Amer.,** October 18.

Journey over sea in balloons, (illustrated).—**Umschau,** October 11.

Accidents in aerial navigation.—**Umschau,** October 25.

Russian experiments with fixed balloons in campaign.—**Wochenblatt,** October 4.

Automobiles in various foreign armies.—**A. S. M. Zeit.,** August 30.

Report on the war office motor lorry trials.—**Eng.,** September 5; **U. S. Gaz.,** September 6; **Eng. Mag.,** November.

The motor car for military purposes.—**Eng'ing.,** September 5.

Use of automobiles from a military point of view.—**R. Inf.,** August; **M. de Art.,** August; **R. Mil.,** Brazil, July.

Bevel gears for driving automobiles.—**Pop. Mech.,** September 27.

The war automobile.—**Scien. Amer.,** September 27.

Automobiles for war service.—**Cas. Mag.,** October.

A novel automobile fore-carriage.—**Scien. Amer**, Supplement, October 11.

Mechanical traction and its application in war.—**Cientifico M.,** August 1, 15.

Mechanical transportation.—**Mil. Information Div.,** January.

Self-propelled vehicles at Aldershot.—**Eng'ing.**, October 17.

The motor-car problem.—**Eng.**, October 17.

The motor-car (traction engines) for military purposes, (Austrian maneuvers).—**A. and N. Gaz.**, October 18.

Automobile requirements for military purposes and use in recent maneuvers.—**Engenheria Mil.**, August.

Oil motor cars of 1902.—**Eng.**, October 24; **Eng'ing.**, October 24, 31.

Mechanical traction for military purposes.—**Eng'ing.**, October 24.

Project for the transportation of a light bridge material (by bicycles).—**Cercle**, October 4.

BALLISTICS.

On artillery fire (corrections, height of sites, etc.).—**M. de Art.**, August.

Compilation of general range tables and their use in the solution of problems in artillery fire.—**Mitth. Art. u. G.**, August, September, October.

The vertical projection of the trajectory.—**R. Mil.**, Brazil, July.

Essay on the probability of fire in infantry collective firing.—**A. Belge**, July-August.

Artillery fire on ship-board.—**Boletin**, August.

Progress in interior ballistics.—**M. de Art.**, August.

Firing against the *Belleisle*.—**R. Maritt.**, August, September.

Armor plate at the Dusseldorf exposition.—**Genie C.**, August 23.

The armor plate question.—**A. and N. Gaz.**, September 13.

Krupp armor plate at the Dusseldorf exposition.—**Int. Rev.**, Supplement 42, September.

Naval guns and armor.—**R. Artig.**, July-August.

Notes on ordnance and armor, Armor.—**Naval Intelligence**, July.

The gun v. armor plate.—**Page's Mag.**, October.

Armor, projectiles and military explosives.—**W. Soc. Eng.**, October.

Protection of warships in the 19th Century.—**R. de Marina**, September.

Guns vs. armor.—**R. de Marina**, September.

CHEMISTRY AND PHOTOGRAPHY.

An improved drying oven.—**Scien. Amer.**, September 20.

Chemical industries at the Dusseldorf exposition.—**Eng'ing.**, September 12.

A review of some of the recent literature of the Periodic Law.—**Frank. Inst.**, October.

The chemical treatment of water.—**Iron Age**, October 8.

Contribution from the laboratory of sanitary chemistry.—**Tech. Quart.**, September.

The electrolytic manufacture of chlorates.—**Elec. Rev.**, October 11.

The efficiency of photographic shutters.—**Tech. Quart.**, September.

Electrical blue-printing machine.—**Pop. Mech.**, November 1.

Apparatus for stereoscopic photography.—**Scien. Amer.**, Supplement, November 8.

A new device for stereoscopic photomicrography.—**Frank. Inst.**, November.

DRILL REGULATIONS, MANEUVERS AND PRACTICE.

Provisional drill regulations for the British army.—**Wochenblatt**, August 27; September 3.

Firing instruction at the Royal Military Academy.—**R. Mil.**, Portugal, August 31; September 15, 30.

Cavalry maneuvers.—**Armee et Marine,** September 7.

Army maneuvers of 1902, with maps, (French).—**Armee et Marine,** September 7, 14, 21.

Tactical handbook for Russian officers, provisional field service regulations and scheme for attack by detachments, 1901.—**Wochenblatt,** August 27.

German army maneuvers.—**A. and N. Jour.,** September 20.

Admiral Higginson's report on the maneuvers.—**A. and N. Jour.,** September 20.

The Fort Riley maneuvers.—**A. and N. Jour.,** September 20, 27; October 4-18.

The method of training horses in the Italian cavalry.—**R. Cav.,** August, September.

Russian artillery in the maneuvers of 1902.—**R. Art.,** August.

The French naval maneuvers.—**Eng'ing.,** September 12, 19, 26; **R. G. de Marina,** September, October; **Rundschau,** October.

Troops and non-commissioned officers' instruction and training.—**R. Inf.,** August.

Grand maneuvers in Belgium.—**Int. Rev.,** September.

Artillery and engineer troops in the maneuvers of 1901, in France.—**Schweiz Mil. Blatter,** August.

Considerations on musketry training in the navy.—**R. Maritime,** August.

Handbook for the artillery service.—**Boletin,** June, July.

Reflections of a Swiss officer on the maneuvers of Haute-Savoie.—**Cercle,** September 13.

An expert opinion of the maneuvers.—**A. and N. Jour.,** September 27.

Simplification and saving of time in the training of infantry.—**Jahrbucher,** September.

Training for war.—**Jahrbucher,** September.

Maneuvers with electric search lights for coast batteries.—**Boletin,** July.

The German Imperial maneuvers, 1902.—**A. and N. Gaz.,** September 20; **Die Armée,** October 3.

U. S. Army and Navy maneuvers, 1902.—**A. and N. Gaz.,** September 20; **U. S. Gaz.,** September 20; **A. and N. Reg.,** September 13; **Yacht,** October 4.

Applied questions in field service.—**R. Inf.,** September.

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Outlines of the condition of training of the French infantry.—**Rus. Voy. Sbo.,** August.

Representation of battle targets for infantry.—**Die Armée,** September 12.

Something about night maneuvers.—**N. M. Tids.,** July.

Alpine maneuvers in Haute-Savoie.—**Armée et Marine,** September 28.

Tactical instruction and training of younger infantry officers.—**Die Armée,** September 19.

Dummy targets of infantry and artillery, worked by automatic machinery.—**U. S. Gaz.,** September 27.

Musketry training in the English army.—**U. S. Gaz.,** September 27.

Combined army and navy maneuvers.—**United Serv.,** October.

Imperial German maneuvers, 1901.—**A. Etrangeres,** April, May, June.

Notes on ordnance and armor, target practice and gun trials.—**Naval Intelligence,** July.

Naval maneuvers of 1901, (England, France, Germany and Russia).—**Naval Intelligence**, July, 1902; **Yacht**, October 18.

Autumn maneuvers of the IV army corps.—**A. S. M. Zeit.**, September 27; October 4.

Results of the firing inspections, (Russia).—**Die Armée**, October 3.

Maneuvers of the different nations in 1901, 1902.—**Mil. Information Div.**, January.

Field firing, its use and abuse.—**A. and N. Gaz.**, October 18.

Instruction and training in individual fire.—**Belgique M.**, October 12.

Training the recruit.—**Jour. U. S. Cav.**, October.

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The coast joint maneuvers, 1. Narragansett district, 2. A study in preparation.—**Jour. M. S. I.**, November.

Combined maneuvers in the Mediterranean.—**U. S. Gaz.**, October 18.

Suggested improvements in military riding and breaking.—**Jour. R. U. S. I.**, October.

Detachment maneuvers in the St. Petersburg military district.—**Wochenblatt**, September 27; **Exercito**, September.

Tactical maneuvers of the English fleet in the channel, 1902.—**Rundschau**, October.

Lord Roberts' infantry drill regulations for 1902, in comparison with similar regulations in Germany, Italy, France, Austro-Hungary and Russia.—**Organ**, LXV. 3.

French military matters; fortress maneuvers around the camp of Chalons.—**Wochenblatt**, October 1.

Lord Roberts and English musketry training.—**Ceintifico M.**, August 15.

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Maneuvers of the Italian army, 1902.—**Wochenblatt**, October 4.

Considerations on machine gun firing (Rohne).—**Wochenblatt**, October 8, 11, 15.

Conclusion of the Russian grand maneuvers at Kursk.—**Wochenblatt**, October 15.

The value of drill and its limits.—**Wochenblatt**, October 18.

Latest regulations on the instruction and training of the Russian infantry and cavalry personnel in artillery service.—**Wochenblatt**, October 18.

Drill regulations and firing instruction for machine gun groups.—**Die Armée**, August 22, 27.

French R.F. field artillery, its methods, etc.—**A. and N. Jour.**, September 20.

Opening of the artillery firing practice grounds at Souges (near Bordeaux) 25th divisional artillery.—**Armée et Marine**, October 5.

On the aiming and pointing of coast artillery guns.—**R. Maritt.**, August, September.

Control spectacles for instruction of gunners.—**A. and N. Reg.**, September 13.

Naval gunnery and its improvement.—**Eng.**, September 19.

ELECTRICITY.

Wireless telegraphy.—**Club Mil. Nav.**, August; **Genie C.**, September 6, 13; **Eng'ing.**, September 5; **Naval Intelligence**, July, 1902.

Pickard wireless telegraphy apparatus.—**West. Elec.**, September 13.
Progress in space telegraphy.—**West. Elec.**, September 13.
Wireless telegraphy and Maxwell's theory.—**Elec. World**, September 13.
DeForest wireless telegraphy system in the war maneuvers.—**Elec. World**, September 13.
Disappointing results with naval tests in wireless telegraphy.—**West. Elec.**, September 20.
Space telegraphy operations by Signal Corps during maneuvers.—**West. Elec.**, September 20.
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Space telegraphy at German war maneuvers. - **West. Elec.**, September 20.
Wireless telegraphy by the Slaby-Arco system.—**Elec. Rev.**, September 27.
Signalling through space without wires.—**Elec. World**, September 27.
Field telegraph service; Italian volunteers in the campaign of 1866.—**R. Artig.**, July-August.
Development of wireless telegraphy.—**Page's Mag.**, October.
High-speed telegraph system.—**Scien. and Indus.**, November.
A review of wireless telegraphy engineering practice.—**Eng. Mag.**, November.
The latest position of wireless telegraphy.—**Organ** LXV, No. 2.
Wireless telegraphy apparatus.—**Amer. Elec.**, November.
The use and advantages of alternating currents for land telegraphy.—**Elec. World**, November 8.
Baird dry-plate gauge.—**West. Elec.**, September 13.
Checking electrical instruments.—**Elec. Rev.**, September 27.
Electricity on board warships.—**Club Mil. Nav.**, August.
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Water rheostats for testing purposes.—**Scien. and Indus.**, October.
Some engines and generators at the Dusseldorf exposition.—**Amer. Elec.**, October.
Prof. Pupin's invention for reducing the attenuations of electric waves.—**Tel. Mag.**, September.
Notes on electricity.—**Naval Intelligence**, July, 1902.
Fort Wayne electrostatic ground detector.—**West. Elec.**, October 18; **Elec. World**, October 18; **Elec. Rev.**, October 18.
A cell for measuring the electrical resistence of liquids.—**Phys. Rev.**, October.
Some points about connecting up shunt motors.—**Scien. and Indus.**, November.
The principles of electrical measuring instruments.—**Scien. and Indus.**, November.
Measuring high resistance by Wheatstone bridge.—**Scien. and Indus.**, November.
A new automatic interrupter.—**West. Elec.**, November 1.
Electric fittings on board ship.—**Seewesens**, No. X.
Electric installations of the battleships *Deodora* and *Floriano*.—**R. Mil.**, Brazil, August.
Electrical testing laboratory.—**Elec. World**, November 1.
Combined ammeter and double voltmeter.—**Elec. World**, November 1.
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Alternating current.—**Inst. Elec. Eng'rs.**, August, September.

Single phase alternators.—**Inst. Elec. Eng'rs.**, August, September.
On the determination of alternator characteristics.—**Inst. Elec. Eng'rs.**, August, September.
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Search lights in the maneuvers.—**West. Elec.**, September 20; **A. and N. Jour.**, September 20.
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New type of enclosed arc lamp.—**Elec. World**, October 4.
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Electric lighting of Fort Don Carlos I. (Lisbon).—**Engenheria Mil.**, August.
Electric motors with variable speed.—**Genie C.**, October 18.
Electric dynamos and motors.—**Z. Architek. Vereines**, October 17.
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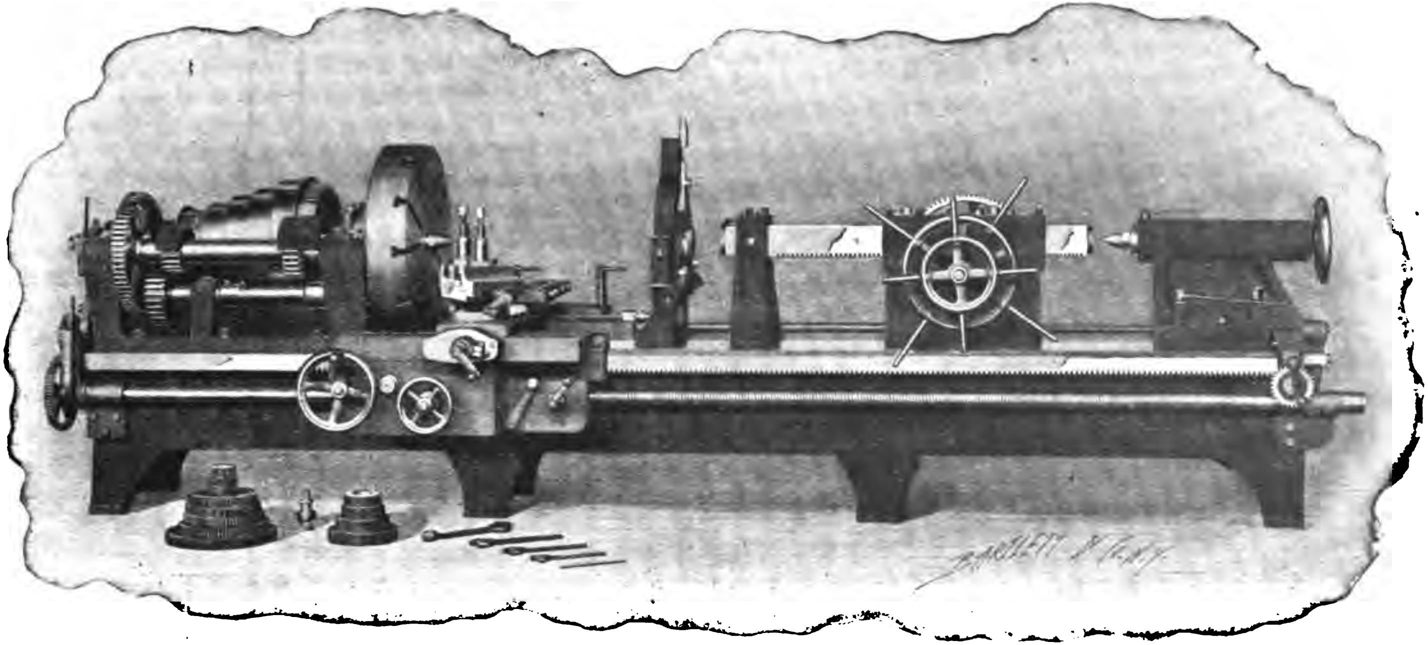

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